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EDITORIAL

THE NEW SESSION

ONCE again the schools are entering upon a new session. On such occasions one's thoughts are inclined to turn in mellow retrospect upon the past, to contemplate upon and criticise the present and to prognosticate upon the future with a visionary anticipation.

The training schools are the nurseries of the profession for it is within their portals that the craftsmen and scientists of the future are moulded and nurtured in thought and action so that on graduation they can be transplanted into the many and varied fields of endeavour and flourish with credit to themselves, their teachers and to their profession.

One of the most wholesome features of our calling is the intense interest that the average practitioner, be he a worker in the laboratory or in the field, evinces in his profession especially as regards the individual member's competence, his devotion to his task, his integrity and the service that he can render to the public. These attributes often become so absorbing that many men and women take little interest and no active part in the day to day affairs of the world around them. They become the slaves of their own art and science. It is probably this attitude to life which has stimulated and encouraged the deep interest in the training of our undergraduates which has always been so manifest when veterinary surgeons gather together. Every member has his own firm idea on the arrangement of the curriculum and the importance of this or that subject and the quality and specificity of the examination tests for competence. No subject can arouse more forceful and even acid discussion in any concourse of veterinary surgeons and

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opinion runs so strong that rarely is there concord. Now concord and harmony are good things in themselves but when they arise from a lack of interest or effort they may engender the spirit of *laisser-faire* and somnambulism. No one could accuse our profession of these defections when the subject of veterinary education holds the stage and to such moment as is the case at the present time.

The last five years have witnessed the greatest change that has occurred in the system of veterinary education since the profession was conceived 150 years ago. The schools have been absorbed within the University system and by this time the new curricula are well under way at all centres.

It is well to cogitate for a while upon the true meaning of the word University, for there are some who may think that the recognition of a school and the change in title represents an end to all difficulties. This is far from the truth and the main task of proving the value of the new idea will rest upon the schools just as it did when they were independent bodies. It is a moot point whether the vocational studies can be pursued better in isolation or in community. To assess the benefits that may accrue from the University system it is wise to consider the true meaning of the word. It was a name coined to describe those places where in olden times learned dilettantes were wont to foregather sometimes in soliloquy and other times in commune. To these places men in search of knowledge would travel from all parts of the known world in order to sit at the feet of the masters. By debate and contact the seeds of culture were sown and the scholars in their turn became ardent missionaries spreading knowledge and culture throughout the world. These Universities are the true seats of learning for it is by this contact and commune between people of varied interests that the true benefits of the University system of education is exemplified best and not primarily from the vocational point of view. On the other hand those who follow some vocational interest can gain much by contact with their fellows in other walks of life—socially, vocationally and culturally. Let us remember that the prefix University is not the abracadabra of all scholastic ills. A University can exist without a College and a College without a University. If the association be good and true the benefits which will undoubtedly follow can be immeasurable.

GENERAL ARTICLES

NEOMYCIN AS A TREATMENT FOR BOVINE MASTITIS*

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THE antibiotic neomycin was discovered by Waksman and Lechevalier (1949) and its range of antibacterial activity was defined by Waksman, Frankel and Graessle (1949). It was found to be active against a wide variety of bacteria, both Gram-negative and Gram-positive. Any new antibiotic is of interest to veterinarians, and it seemed possible that neomycin might prove a useful addition to the treatments for bovine mastitis in view of its wide antibiotic spectrum. A new antibiotic, if it is to be of value in mastitis treatment, should be at least as effective as penicillin for sterilisation of *Str. agalactiæ* infections and should be more effective for the treatment of the more resistant conditions caused by staphylococci and other streptococci, diphtheroid bacilli and Gram-negative organisms.

The following work was undertaken to ascertain whether, in fact, neomycin was an effective treatment for bovine mastitis. When we began our studies the only published work relating to mastitis treatment with neomycin was by Drury (1952), who obtained satisfactory results in the treatment of 405 cases of mastitis caused by a variety of bacteria.

Our work is described in two parts, Part I being an account of the laboratory studies and Part II a description of the treatment of infected cows.

Part I—Laboratory Studies on Neomycin

Drury (1952) was the first to report on the use of neomycin for the treatment of bovine mastitis, and his results showed the causal organisms to be sensitive to the antibiotic *in vitro*. Details of the technique were not given in his paper, but further information was obtained from Messrs. Upjohn, and it was found that the medium used for sensitivity tests was Difco nutrient tryptose broth at *pH* 8.0, the *pH* at which neomycin showed most activity. This medium was, therefore, used for the initial sensitivity tests to see if the organisms isolated here gave similar *in vitro* results.

Methods

1. *Sensitivity of mastitis organisms to neomycin.*

Cultures of organisms freshly isolated from cases of bovine mastitis were grown, after identification, in Difco tryptose broth *pH* 8.0. Cultures grown for 18 to 24 hours at 37° C. were standardised by opacity so that a 10^{-4} dilution would give approximately 100,000 organisms per ml. The cultures were diluted

* Received for publication May, 1954.

10^{-3} in sterile distilled water, with a final dilution in the test medium, immediately before addition to the neomycin dilutions. An exception was made with the slow-growing *C. pyogenes* cultures, which were grown in 20 per cent serum broth and diluted to 10^{-2}. Later, comparative tests were done in sterile skim milk with brom-cresol purple indicator, and for this purpose cultures were grown in 0.05 per cent glucose broth *pH* 7.6, and diluted as above.

Neomycin sulphate was dissolved in phosphate buffer solution *pH* 8.0 so as to give a concentration of 400 mcg. ml. and filtered through a sintered glass filter. A serial dilution technique was used for the tests, doubling dilutions of neomycin being made in 0.5 ml. amounts of the test medium. 0.5 ml. amounts of the diluted test cultures were added to the dilution tubes and the material incubated overnight.

The reliability of the neomycin solution was checked daily by including a sensitivity test on a standard organism, *Bact. friedlander* (*Klebsiella pneumoniæ* strain PC1/602) obtained from Messrs. Upjohn. End points were determined by naked eye visible growth in the tryptose broth, and change of indicator colour in the skim milk.

2. *Assay of neomycin in milk after infusion of the udder.*

The technique adopted was developed by Hansen and Collingsworth (1949) and the details were obtained from Messrs. Upjohn.

The medium used was Difco streptomycin assay agar *pH* 8.0, to each litre of which was added about 7 mls. of a spore suspension of a specially sensitive strain of *B. subtilis* (28/FZ 1). Plates were poured with 5 ml. amounts of this medium and allowed to set on a level surface, so as to obtain a uniform thickness of agar. Filter paper discs, Whatman paper No. 1, $\frac{1}{4}$ in. in diameter, were used for the test, and were dipped in the solution to be assayed and placed on the surface of the agar.

A set of standards was prepared each day by dissolving neomycin sulphate in sterile skim milk so as to give concentrations of 16, 8, 4, 2, 1 and 0.5 mcg. ml. neomycin respectively. To prepare the standard curve, filter paper discs containing the six standards were distributed on a plate and five replicate plates prepared. After overnight incubation at 37° C. the diameters of the zones of inhibition were measured in mm. and the diameters of replicate zones averaged. Zone diameters of the six standards were plotted against mcg. ml. of neomycin to obtain the standard curve.

Milk samples were obtained from the treated cows at intervals, after discarding the fore-milk, and on receipt in the laboratory were heated for 20 minutes at 60° C., to kill any contaminating organisms. Five discs containing solutions under assay were placed on each plate, the sixth disc containing a known standard, and five replicate plates were put up for each set of tests. After incubation, zone diameters were read and averaged and these figures were converted into mcg. neomycin per ml. by using the standard curve. When levels greater than 16 mcg. neomycin per ml. were expected, the milk samples were diluted in sterile skim milk so as to obtain a reading within the standard range.

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Results

1. *The sensitivity of mastitis organisms to neomycin.*

The sensitivity of a number of strains of mastitis bacteria to neomycin is shown in Table I.

TABLE I

Sensitivity of organisms to neomycin in Difco tryptose broth.

Type of organism	Mcg./ml. inhibiting growth 0.04-0.16	0.31-1.25	2.5-5.0	>5.0
Str. agalactiæ ...	3	4	6	—
Str. dysgalactiæ ...	1	—	—	—
Str. uberis	2	4	2	—
Staph. pyogenes ...	6	4	—	—
C. pyogenes ...	4	1	—	—
Bact. coli	1	2	—	—

Numbers in the columns represent the number of strains of bacteria sensitive to each range of neomycin concentration.

Comparative tests in other media, including skim milk, suggested that neomycin was less active than in Difco tryptose broth. An indication of the reduction of activity which takes place in milk is shown in the following comparative tests on representative strains of bacteria.

As it was thought that tests in milk were most likely to give an indication of antibiotic activity in the udder, it was decided to test 100 strains of mastitis bacteria against neomycin in skim milk. The results are set out in Table III.

TABLE II

Mcg./ml. neomycin required to inhibit organisms in tryptose broth and milk.

Type of organism	Tryptose broth	Milk
Str. agalactiæ ...	0.04	>10
	0.15	>10
Str. dysgalactiæ ...	0.04	0.6
Str. uberis	2.5	>10
	0.6	>40
Staph. pyogenes ...	0.15	40
	0.04	5
Bact. coli	0.6	>10
	1.25	>10

It was obvious from these results that a concentration of >40 mcg./ml. of neomycin was required to inhibit the majority of these mastitis bacteria in skim milk medium.

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TABLE III

Sensitivity of 100 strains of mastitis organisms to neomycin in skim milk.

Type of organism	Lowest conc. of neomycin inhibiting growth (mcg./ml.)					Total No. of strains
	5	10	20	40	>40	
Str. agalactiæ ...	—	—	1	1	13	15
Str. dysgalactiæ ...	—	1	1	—	19	21
Str. uberis ...	1	1	—	1	12	15
Staph. pyogenes ...	5	7	3	13	4	32
C. pyogenes ...	—	—	3	5	8	16
Str. bovis	—	—	—	—	1	1

Numbers in the columns represent number of strains of bacteria sensitive to each concentration of neomycin.

2. *Assay of neomycin in milk after infusion of the udder.*

It was necessary to find out for what length of time the antibiotic persisted at curative levels in the udder. The results of assays on milk samples from normal cows infused with neomycin are set out in the following three tables. All results are expressed in micrograms neomycin per ml., and all quarters whether infused or not were assayed.

TABLE IV

Cow—Wilma

Treatment—500 milligrams in R.F.and R.H. quarter
1000 milligrams in L.F. quarter.

	L.F.	L.H.	R.F.	R.H.	Bulk
Pre-treatment	0	0	0	0	0
5 hours after treatment	250	0	30	110	55
21 „ „ „	52	0	4	44	not assayed
30 „ „ „	16	0	4·4	14	11
45 „ „ „	1	0	2·4	2·4	5

TABLE V

Cows—Ivy, Wilma

Treatment—500 milligrams in two quarters and a further 500 milligrams after 24 hours.

	Ivy				Wilma			
	L.F.	R.F.	L.H.	R.H.	L.F.	R.F.	L.H.	R.H.
8 hours after 1st treatment	0	180	80	0	0	33	50	0
24 „ „ „ „	0	42	29	0	0	7	17	0
8 „ „ 2nd „	0	115	170	0	0	43	80	0
24 „ „ „ „	0	27	21	0	0	29	18	0
32 „ „ „ „	0	7	4	0	0	5	3	0
48 „ „ „ „	0	4	5	0	0	1	11	0

TABLE VI

Cows—Ada, Winnie, and Bunty

Treatment—500 milligrams in four quarters and a further 500 milligrams after 24 hours.

	Ada				Winnie				Bunty			
	L.F.	R.F.	L.H.	R.H.	L.F.	R.F.	L.H.	R.H.	L.F.	R.F.	L.H.	R.H.
8 hours after 1st treatment	75	100	90	47	90	110	100	110	40	75	40	32
24 „ „ „ „	44	32	20	38	20	44	28	>16	20	36	24	16
8 „ „ 2nd „	100	70	50	65	220	220	120	250	80	250	65	80
24 „ „ „ „	44	>32	>16	>32	44	>32	28	12	44	44	28	24
32 „ „ „ „	8	20	12	5	14	>16	4	>16	>16	>16	14	>16
48 „ „ „ „	2	2	1	1	2	>16	2	1	*	16	1	3
56 „ „ „ „	1	2	<1	1	1	6	0	1	>16	12	1	8

* Not assayed.

A study of these tables shows that in some cases the level of neomycin in the udder 24 hours after infusion is well below 40 mcg. per ml. On the basis of sensitivity tests on bacteria in skim milk, it seems likely that the antibiotic at that stage will be inactive against some mastitis organisms.

3. *Local irritancy in the udder.*

Three cows in the latter halves of their lactations, and three cows in full milk were infused with neomycin—none of the cows was infected prior to infusion. The low yielding cows were infused in alternate quarters, and the heavy yielders in all quarters. Neomycin had no appreciable effect on the milk yields which, with minor variations, continued at their previous levels. Nevertheless there was some evidence of local irritation, in that the infused quarters showed slight swelling and the leucocyte counts in the milk were considerably increased shortly after infusion.

Part II—The Treatment with Neomycin of Mastitis Infections in Cows

The cows which were treated were referred to us by the courtesy of local veterinary surgeons. The mastitis in these animals varied in severity from acute infections showing gross inflammation of the udder with systemic symptoms to inapparent infections which were only detected by bacteriological examination of the milk. All the cows were examined, sampled and treated by one of us (D.L.H.).

No cows are included in our results which were not bacteriologically sampled at least once before treatment. After treatment with neomycin all the cows were sampled at approximately weekly intervals for at least a month unless they became bacteriologically positive sooner or showed so little clinical improvement that other treatment became necessary. The neomycin treatment was not accompanied by any other therapy at the same time. A case was regarded as a treatment failure if the bacteria isolated in the pretreatment samples were also recovered from any of the post-treatment samples of the same quarter.

Methods

Milk samples were inoculated, within one or two hours of their collection, directly on to the surface of ox blood æsculin agar. The inoculum was three drops of shaken milk dropped on to the surface of the medium from a 30 dropper pipette, an inoculum equal to 0.1 ml. of milk. The plate was rotated and tilted to spread the inoculum over the surface—these comprised the direct milk samples. The milk samples were then placed in a 37° C. incubator overnight and stroked out next morning on to Edwards' crystal violet æsculin blood agar containing 1/2,000 thallium acetate.

Plates were examined after 48 hours' incubation. *Staph. pyogenes* was confirmed by coagulase production, *Str. dysgalactiæ* by biochemical reactions and positive precipitation with anti-streptococcal group C serum, *Str. uberis* by

biochemical reactions, and *C. pyogenes* by biochemical tests and ability to liquefy solid serum.

The neomycin was administered as 500 mg. of neomycin sulphate in 3.5 g. of ointment base in the usual type of collapsible intra-mammary tube*. The neomycin was infused up the teat canal after the contents of the quarter had been milked out, when it was possible. Each infected quarter was treated twice, at 24- or 48-hourly intervals.

Results

The results are presented in Table VII.

TABLE VII

	No. treated	Failures	Successes
Cows treated	20	16	4
Udder quarters treated	40	25	15
Staph. pyogenes infected quarters	11	7	4
Str. uberis infected quarters ...	13	9	4
Str. dysgalactiæ infected quarters	12	4	8
C. pyogenes infected quarters ...	4	4	0

Discussion

It will be noted that our material included neither infections with *Str. agalactiæ* nor infections with gram-negative bacteria. It has been amply demonstrated that infections with *Str. agalactiæ* respond extremely well to penicillin and as yet infections with gram-negative bacteria are not an important feature of mastitis in this country. It follows that if a new antibiotic is to be an advance in mastitis treatment it should be active against the other bacteria causing mastitis. Our results do not suggest that neomycin will be of much value for these other infections.

The discrepancy between our results and those of Drury (1952) may be explained by differences of technique. It was pointed out in Part I that the use of tryptose broth for sensitivity tests gave unduly favourable results compared with those obtained in skim milk medium. Assuming that *in vitro* results are a guide to activity in animal tissues, an assumption questioned by Edwards (1952), it is obvious that the choice of medium for the sensitivity tests is of great importance. Comparing results obtained in Hartley broth and milk, Edwards (1952) found that streptomycin and nisin were much less effective in milk medium, although penicillin and aureomycin results were not appreciably dependent on the medium. In our opinion skim milk would seem to be the most suitable medium for the *in vitro* testing of the sensitivity of mastitis bacteria to antibiotics.

It is not clear on what Drury (1952) based his assessment of bacteriological

* Messrs. Upjohn's Teatube Neomycin.

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cure, but reliance appears to have been placed on direct microscopic examination of incubated milks, a technique which in our experience is unreliable.

Since our work began similar treatment results to those of Drury have been published by Braeutigam (1953), but again diagnosis was based on examination of microscopic films. On the other hand, Tucker and Johnson (1953) obtained the following results after neomycin treatment; 27 per cent of 108 *Str. agalactiæ* infections were cured, 41 per cent of 64 other streptococcal infections, 25 per cent of 56 *Staph. pyogenes* infections, 22 per cent of nine *Bact. coli* infections and 40 per cent of 43 *Pseudomonas* infections. Confining their observations to *Str. agalactiæ* infections, Simon, Radivojehic and Reese (1954) found neomycin to be inferior to penicillin. Both these teams of workers based their assessment of cure on fairly stringent bacteriological cultural diagnosis.

Our limited observations confirm the results of Tucker and Johnson (1953).

Summary

In vitro sensitivity tests of the common mastitis bacteria to neomycin sulphate showed that tests in Difco nutrient tryptose broth gave very sensitive results which were not substantiated when skim milk was the test medium.

Assuming that the results in skim milk medium are more likely to mirror conditions in the udder, it was found that neomycin levels in milk 24 hours after infusion of 500 milligrammes of neomycin sulphate were on occasion below the concentration required to inhibit certain strains of mastitis bacteria.

The clinical and bacteriological results of treating mastitis in cows showed that 16 cows out of 20 were not cured. The 40 quarters involved were infected with *Staph. pyogenes, C. pyogenes,* and streptococci other than *Str. agalactiæ,* 25 of these quarters were not sterilised.

Acknowledgments

We are grateful to Messrs. Godber and Waite, Ms.R.C.V.S., for allowing us access to the cows under their care. We are greatly indebted to Messrs. Upjohn of Kalamazoo, Michigan, U.S.A., for supplies of neomycin, and for their helpful technical advice. This work would not have been possible without the technical assistance of Misses Newell and Blomfield. This article is published with the permission of the Directors of Boots Pure Drug Co., Ltd.

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ANIMAL HUSBANDRY, ANIMAL INDUSTRY AND ANIMAL DISEASE IN THE SOMALILAND PROTECTORATE

Part I

By ROBERT G. MARES, M.R.C.V.S.

Acknowledgments and Prefatory Notes

THIS paper is based on two years' experience of the Somaliland Protectorate gained while working as Veterinary Officer under Mr. E. F. Peck, B.V.Sc., M.R.C.V.S., D.T.V.M., the Director of the Department of Agricultural and Veterinary Services. Mr. Peck suggested the writing of the paper, and, besides giving constant advice and encouragement, freely gave the use of his own notes on the Somali flora and the benefits of nearly 10 years' experience of the country.

The Somali members of the Department were very helpful in the checking and expanding of the material presented.

The botanical names of the plants were correlated with their Somali names with the aid of Peck's notes and the check list by Glover (1947).

The spelling of the Somali words presented a difficulty and is not uniform; place names are spelt according to the " Somaliland Gazetteer " published under the authority of the Military Government, Somaliland Protectorate (1946); plant names according to Glover's check list and other words arbitrarily. A glossary is attached in which the arbitrary spelling has been correlated with the new orthography that is likely to become the official one for the Protectorate. This was done with the help of Mr. B. W. Andrzejewski and Mr. Musa Haji Ismail, of the London School of Oriental and African Studies.

Mrs. J. M. Laurence kindly permitted a few notes to be made from the manuscript of her introduction to her collection of Somali poetry and prose.

Introduction

The Country and Climate

FOR the purpose of this paper Somaliland means the area of land grazed by the stock of British-protected tribes. The southern political boundary of the British Protectorate is artificial: most stock-owning Somalis depend on grazing outside it for several months every year. A general survey of Somaliland has been made by Hunt (1943 to 1949 and 1952). Reports on the vegetation have been made by Gillett (1941), Edwards (1942), Glover and Gilliland (1945), and Glover (1946 and 1947). MacFadyen has studied the geology (1933), and also reported on the vegetation (1950). Good general descriptions of the country are found in the books of Burton (1856), Swayne (1895), Drake-Brockman (1912) and Archer (1937).

Somaliland is divided into three ecologically distinct districts called the *Haud*, the *Ogo* and the *Guban*.

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The *Guban,* meaning burnt, gets its name from its climate. It includes the fiery coastal plain and the equally hot and barren maritime hills. It is bounded on the south by the sharply rising escarpment of the main east-west mountain range. The only rainfall consists of scattered showers during the comparatively cool months, October to March, and is sometimes heavy enough to bring out a little greenery and blossom. For the rest of the year the climate is fierce, and, from June to September, a hot scorching wind makes it even worse. The vegetation is scarce, salt-bush and dune-grass near the coast, and blasted thorn tree and scrub-bush inland. There are a good many permanent water points where the general barrenness is relieved by a slightly greener vegetation.

The *Ogo,* which means high, extends from the top of the escarpment southwards to an east-west line connecting the southernmost permanent water points. This line runs from Jigjiga in the west roughly along latitude 9.30′ to Odweina (9.24′ 45.04′), then east-south-east to Bihen (8.26′ 48.25′). The *Ogo* is a plateau decreasing in altitude from 6,000 feet on the escarpment edge to about 3,000 feet at the line given.

The *Haud,* which means south, continues south from this line as a plateau still decreasing in altitude. It has no permanent water, and its southern boundary may be considered as another line of wells far to the south of the political border.

The climate is never unbearably hot in the *Ogo* and the *Haud.*

The four Somali seasons occur roughly in the four quarters of the year: the exact dates are worked out by the Somalis by the sun. The *Jilal* is the dry winter season, fairly cool and with little rain except for showers in the *Guban.* The *Gu* is the spring rain season, and the *Gu* rain, in April or May, is the rain on which the country depends most: the fall can be up to 20 in. on the higher land. The *Hagar* is the windy summer season: the south-west monsoon blows, and the light *Karan* rain falls in the higher places of the *Ogo.* The *Dair* is the autumn rain season, and the *Dair* rain, which falls in September and October, is second in importance to the *Gu.* Full details of rainfall and seasonal changes are given by Hunt (1943 to 1949 and 1952).

The vegetation changes with the altitude, and follows a regular pattern from the escarpment southwards except where large tracts of gypseous soil carry their own characteristic flora such as salt bush and the so-called gypseous grasses. At the highest places are juniperous forest relics, and lower are the potential forest lands marked by the handsome tree-like Euphorbias. Southwards at the next level are *Acacia etbaica,* various species of Aloes, grassy plains and park-like areas. At this altitude cultivation is increasingly practised by the cattle-owning Somalis, who live mainly in the west. Lower are *Acacia bussei* and more grass lands with Aloes less common. Throughout the *Ogo* soil erosion is progressing at an alarming rate, particularly round the wells. The urgency of this problem and ways of dealing with it have been set out most compellingly by Glover (1946).

In the *Haud* the open grass plains are dotted characteristically with termitaria, and alternate with huge expanses of low bush country. The land is flat

(*Article by Mares, page 411*)

Fig. 1

Somali male nomad. The background is typical low bush country in the south-east.

Fig. 2

Somali nomad woman. The background is rocky country in the west with Euphorbias.

Fig. 3

The house supports and covering mats loaded on a burden camel.

FIG. 4.
Throwing water from a shallow well in a dry river bed.

FIG. 5.
Oxen ploughing in the west of Somaliland. The farmer has asked his friends to help, and will kill a camel and make a feast for them when the work is done.

FIG. 6.
Loading sheep from the quay to a lighter at Berbera. From the lighter they are lifted in baskets into the hold of a small steamer. (Photograph by Peck).

(*Article by Mares, page* 411)

and the soil red and virtually uneroded except in the natural basins, wide and shallow, where temporary lakes form after rain. Here the bush gives way to Acacia trees, and semi-permanent settlement is just starting to destroy the ground cover and produce erosion.

The People and their Homes

The majority of Somalis are nomadic herdsmen, and it is with them that this paper is chiefly concerned. Some mention, however, will be made to the cattle-owning Somalis who live in the west and who are starting to adopt a more settled agricultural life.

Nomadic life is forced on the camel-owning Somalis by the nature of the country and climate, and this has, in its turn, determined the social structure of the nomadic community.

The British-protected tribes are divided into sections and sub-sections based on the social unit of an extended family; that is father, mother, children, uncles and cousins. This unit is held togther by economic necessity, and is of a size best fitted to survive under the harsh conditions of the country. Within the units sections are regulated by individual reciprocal duties and division of labour, but, between units, behaviour varies from friendly to hostile: alliances are cemented by marriage: feuds are perpetuated by murder. Without the imposition of colonial rule this system is biologically advantageous, because the conditions of chronic desert warfare keep the population within the limits that the country is able to support, Wright (1943).

Tribal existence depends on the stock, water and the grazing, so that disputes concern these, and settlements are based on them. Unwritten laws and customs, differing in detail from tribe to tribe, determine the settlements. Compensation for wounding starts with a sheep: a man's life is worth a 100 camels and a woman's 50. Near relatives are expected to share in these payments. After a fight assessment is made in standard camels, equal to nine sheep each. Cash payments may be made to-day but still involve stock as these must be sold to raise the money. A marriage may help to compose a settlement, bringing with it grazing and watering rights, and, always, a bride price of stock from the young man to the father of his intended bride. When a male child is born stock is at once set aside for his manhood.

The stock and its welfare takes a predominant place in conversation: a man, returned from a journey, will sit down in a circle of friends and tell over every detail of the state of the grazing and the condition of the stock that he has seen on the way. The unwritten poetry, recitation of which forms almost the only cultural relaxation, is full of references to stock, Laurence (1952). One long poem covers the art and science of camel husbandry from A to Z. At the end of the last war the news was given to a nomad; he thought this was interesting, but was much more excited to tell his informant that rain had fallen not far away, Hunt (1952).

Typical nomadic Somalis are shown in Figs. 1 and 2. They belong to the Islamic faith and are extremely independent in character.

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The nomadic house has been described by Drake-Brockman. It looks like a large bee-hive and is made of curved poles covered with grass mats. Each house is occupied by a man and his wife with their youngest children: a man with more than one wife has more than one house. The house is surrounded by a fence of cut thorn branches, and the two together make the smallest pastoral unit called the *rer*. The *rer* is usually bigger than this and several houses will be arranged in order of precedence in a ring inside the fence. Within the ring of houses is a central pen for the sheep and goats. This pen is partitioned so that the stock of each family is kept separate at night. A few burden camels will sleep by the houses, but the main camel herd has a separate thorn enclosure nearby.

When conditions make a move imperative the women of the *rer* take down the houses and load them on the burden camels (Fig. 3). The men help to load heavy articles such as bags of grain and the large milk and water containers. The average household has enough to load three camels. On reaching the new grazing grounds the women put up the houses while the men cut and place a new fence.

Times of moving to new grazings are determined by the seasonal changes and conform to the following broad pattern. In the *Jilal* the houses of the tribes are in the *Ogo* and the *Guban,* though the camels and their herdsmen will often have to journey to the *Haud* for adequate grazing. As soon as the coastal plain gets too hot, and/or the *Gu* rain starts to fall in the interior, the houses are moved south as far as possible within the limits of the rainfall. After preliminary scouting, and often some fighting, the tribes settle down in the areas most favoured by that year's *Gu* rain. They stay here in the *Haud* while grazing and temporary water pools last; in a good year right through the *Hagar* till the *Dair* rain comes, and on until all the pools are dry again. In a bad year the women and children will move back with their houses, as well as the sheep and goats, to within reach of permanent water in the *Ogo* during the *Hagar*. The camels will stay in the *Haud,* possibly without watering, and their herdsmen will keep themselves alive on the milk. When the effects of the *Dair* rain have quite gone in the *Haud* all the houses are brought back to the *Ogo*. Tribes whose winter quarters are in the *Guban* will move down as soon as it is cool enough, and others will follow them if the showers expected there in January or March are at all heavy. The cycle starts again with the *Gu*.

This migratory pattern is modified in many ways: drums of water for sale are taken into the *Haud* by motor, so that those who can afford it can keep their sheep and goats there even if the pools are dry; rains can fail in the same locality year after year; bad outbreaks of malaria or stock disease, and tribal fighting can frighten a group of families away from their usual areas; and the increasing human population is leading to more and more overlapping of grazing into the wrong area at the wrong season. Previously every tribe had its own grazing ground, maintained more by might than right, and each was grazed in season. Now whenever rain falls there is a concerted rush of man and beast from every place within a day's march or more; villages and even hospitals have been known

to empty overnight. During the 1950-51 drought sections of the Habr Toljaala tribes, whose normal homes were east of Berbera and Burao, came as far west as the French Somaliland border; and other sections, whose homes were near Erigavo, came as far south as Danot. At any time when tribes from the *Ogo* move south their places are taken by tribes pressing in from the *Guban* so that the grazing round the wells in the *Ogo* is never rested. This leads to more and more erosion.

Animal Husbandry

Camels

The Somali camel is described by Leese (1927), who says that it is able to go without water longer than any other breed of camel. It is the most important domestic animal in the country.

Ownership of Camels. Camels are owned by the men and are handed on from father to son. When a male child is born a piece of his umbilicus is sewn into a small leather pouch and hung round the neck of a young she-camel born about the same time. This camel is then the property of the child and so will be her offspring; thus by the time the boy is in his teens he will own four or five young camels. Other stock will also be given him from time to time depending on the wealth and goodwill of his father.

Women may sometimes own a few camels that they have purchased with the money got from selling woven work, sheep and goats, or their milk. When a man dies his stock should be divided according to Shariat law; two shares to the boys, and one to the girls. In practice, however, the girls' share goes to the brothers or near male relatives as an exchange or gift. A woman who owns camels does not get much benefit from them because she will be dependent on men for their care.

Grazing of Camels. Adult camels are grazed by young unmarried men called *gel jirreh,* lit. going with camels. They are usually the sons or near relatives of the owner and get only their keep, which includes camel milk *ad lib* but little else, and perhaps the gift of stock from time to time. A very poor or childless man may be forced to herd his own stock, but a wealthy man will be able to employ *gel jirreh,* not his relations, at a fixed rate in kind of a set of clothing, a pair of shoes and a camel *per annum* in addition to their keep. Most of the *gel jirreh* enjoy their hard life and consider themselves lucky to be free from all ties of women and family.

The camels move independently from the *rer* whenever the best camel-grazing is further from permanent water than the sheep and goats can travel. The erosion in the *Ogo* is enforcing this expedient for an increasingly longer period each year and leading to a disruption of family life.

An important factor in the grazing of camels is the provision of salt. The nomad is most particular to give salt at the proper time because he believes that without it his camels will lose condition, abort and give less milk. Scientific evidence of the importance of salt to Somali camels has been given by Peck (1938 and 1939).

Salt is obtained from salt sand, salt grazing and by buying rough salt from

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Zeila. This latter is fed at the rate of two pounds per camel per year if the two former are not available. The notes on salt and salt grazing that follow are based on a private communicatoin from Peck (1950).

Salt sand is called *arro* and is found in many places. These are recognised by a grey soil with fine surface cracks on the edges of which salt is encrusted, and the salt patch is often darker than the surrounding soil. *Arro* is collected from these places and carried to the *rer* on burden camels: it is common to see camels on the march carrying *arro*. It is fed on a cloth or skin raised on sticks, the camels eat it to satiation and often return to it over a period of four or five days. Both it and salt grazing are given after the camels have had a spell of good pasture after rain.

Arro is not used if salt grazing is available. The best salt plants are *Trianthema crystallina Vahl., Zygophyllum album Linn.,* and some of the *Suæda* species. All these are commonly called *darran* by the Somalis. Camels that graze them for seven to 10 days get all the salt that they need for a year. *Salsola fœtida* and *Salsola crasse* (*gulan*) are nearly as good, and grazing for 10 days gives enough salt for eight months. Camels must always have water after salt or salt grazing unless there is very fresh lush pasture at hand. *Salvadora persica* (*adi*) is not a salt plant that is used much unless other grazing in the vicinity happens to be good or water is plentiful. Camels either need to return to it or get salt in some other way after two months. The same applies to *Mærua Somaliensis, Cadaba rotundifolia* and *Boscia elegans* (*kalan*).

Camels on the coast get salt from *Suæda fructicosa, Suæda monoica* (*haroun*), and from *adi*. These camels are not suited for life in the higher and colder parts of the country once they have become acclimatised to the *Guban*. They demand a high intake of salt and very frequent watering; this earns for them the name of *gahsal,* lit. to wash. There is a superstition that prolonged grazing on *haroun* causes the teeth to fall out; and another, disproved by analysis, that salt content is higher in salt bush in the forenoon.

Apart from the special need of salt, camels live only on the trees, shrubs and grasses of their district. The nomad is an expert on forage plants, and recognises too, many that are poisonous and others that have peculiarities such as tainting the milk. The camel needs a mixed diet for health and those on the grass plains cease to thrive unless given a change. Leitch (1940) gives a comprehensive list of camel forage plants found throughout the world and many of them occur in Somaliland. Peck (1952) has for several years been collecting specimens and notes on the Somali flora and the many uses made of it by the nomad for grazing, for making home and belongings, for medicine and for play. Somalis cut the long dry grass at times to use as hay for a sick animal, or for feeding burden camels that have a long march to make across a barren area.

Conditions of grazing and rainfall may make it needful to split the camel herd. A few burden camels will always stay with the *rer* to fetch water and carry goods to or from a nearby township. The milking camels may be needed to supply the women and children during a dry time: they are called *irman*

and may graze up to a day's march from the *rer* so that the milk has to be fetched on burden camel (*ano qad,* lit. milk taken up). The best grazing is sought for the stud camel, the pregnant camels, the fattening camels and the young weaned camels, all called *ghani,* so that these are sent right away with *gel jirreh.*

Watering of Camels. In the dry season the camel can go 10 to 30 days without water. In the bad drought of 1950-51 they were taking over a week to walk from the wells across the miles of barren and eroding country to the grazings. This meant that they had only a week out of every month on adequate pasture and that for the other three weeks, apart from the short time at water, they were walking the astonishing distance of 300 miles; in spite of this most of the camels of the central tribes survived, though of course not many calves were reared. During the dry period the Habr Yunis and Eidagalla tribes alleviate the thirst of their camels by feeding the chopped up watery roots of plants of the Entada species (*fara dera,* lit. long fingers). During the rains and for as long as the pools remain the herds are not taken to water. Even when the pools in the *Haud* are dry the grazing may be sufficiently succulent to obviate the need for water. In a good year a herd could go without watering at the wells from April to December.

When the herd is due for watering a man is sent in advance to prepare the well and, maybe, to get help from relatives who may live near the well in one of the small villages. Here the bucket and rope may be hired or kept when not in use. Fellow tribesmen give help readily without reward and such mutual aid is very common in all activities of the nomadic life. For the men following with the camels, the day before reaching the wells is considered one of the hardest in their life and has a special name. The night after watering is also given a name, and he who drinks milk on this night from a thirst-quenched camel will lose those thorns that have penetrated his feet, even from childhood; or so they say.

The milking camels are called first to drink, they are then milked and allowed a second, and if they want it, a third drink. The time between drinks is about 20 minutes. The pregnant camels are watered next and then the rest; all are given the opportunity to drink three times. A working chant goes on between one man and his fellows during watering. The tune varies from district to district but the words are similar and run :—

" Drink in health," answer, " and without harm."
(This is sung as the first camel dips its mouth).
" Oh, walk slowly," answer, " You'll get cooler."
" They are come," answer, " They are ours."
" Drink well," answer, " And fill the belly."
" The boy who sucks the front teat " (i.e., of the camel), answer, " Tell him to bring the camels."

The removal of water from the well is done in two ways; if the well shaft is straight and deep the skin bucket (*waddan*) and rope is used; if the water is near the surface, or in a cave, or if the shaft is wide and not deep then the

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water is thrown up from man to man in wooden or woven vessels (Fig. 4). The woven ones are made by the women. The wooden ones, carved by the men from the large Euphorbia " trees," and also from the wood of certain trees, are called *ocoleh*.

Drinking troughs are also made from Euphorbias and are called *gabal*. Troughs are more commonly made by supporting skins on sticks (*gendle* or *nad*), while, in this modern age, old petrol drums cut in half are seen, as well as half inner tubes instead of the skin bucket.

The actions of the water drawers are characteristic, stylish and rhythmical; they work away almost in a trance, vocal and happy, until the work is over.

Breeding and Rearing of Camels. The physiology and husbandry of camel breeding are given by Leese (1927), including a good description of that rarely observed sight, copulation in the camel. Somalis breed from their she-camels every second year, so that two calves are born every three years. The she-camel has her first calf at four years of age.

The male camel is must in the *Gu,* and sometimes at other times if grazing is good. Calves are popular born at the start of the dry season as the result of mating in the *Dair,* and coastal camels are always mated to calve then as it is the best time of year for the *Guban.*

Unlike the Arab, the Somali never works his she-camels and considers it shameful to do so unless driven by the most extreme circumstances; oddly enough he never thinks twice about working his wife!

Most *rers* own a stallion camel, but, in the few cases where they are too poor a neighbour's can be used, or even an uncastrated burden camel. A certain amount of selective breeding is done and a man who owns a good male will allow it to serve females belonging to his tribesmen provided they bring their females to run in the grazing area of the stallion of choice. Preference is given to animals with a light-coloured coat, and to those that drink their fill quickly and without fuss at the wells as well as to conformation and milking capacity.

The stallion is selected from among the young male camels of four or five years old, the rest being kept as burden camels or castrated to fatten; castrated camels can be used for burden work if needed. The owner knows the parentage and family history of every animal and takes this into account with the appearance and health of the young males when making his selection.

She-camels are not culled and each one is bred from if possible. She may live for 20 years and produce eight calves. When she is considered too old she is killed for meat. Unfortunately the decision to kill is often taken when she is several months pregnant. This is partly lack of forethought and partly due to a change for the worse in the grazing conditions.

When a male camel is must he will pursue and mate all empty she-camels whether they are in œstrus or not. When a female has conceived she has a characteristic way of lifting her tail when approached or handled; she dries off naturally and no special effort is needed to ensure this.

Birth is commonly unaided, but if help is needed the nomad will not hesitate

to give a pull, and many of the older men can correct the posture of a limb.

Colostrum (*dumbar*), is drunk by some Somalis as a food and valued by all as a laxative. The amount of colostrum, and later of milk, drunk by the calf, is regulated by tying up one or more teats, depending on the strength of the calf and the milking capacity of the mother. The string used is made from the bark of *Acacia etbaica, Acacia spirocarpa* and *Acacia bussei* (*sugsug, gurah* and *galol*), and is called *mark*. It is cleaned and softened by rubbing with the soapy sap of *Talinum cuniefolium* (*marko maid,* lit. that washes the *mark*).

The lactation period is from eight to 18 months, depending on how soon after calving the mother is mated, and also on the prevailing conditions of climate. Lactation ceases if the calf dies unless a foster calf is produced or the mother conditioned to giving down her milk at the sight of her dead calf's skin.

Fostering is done in three ways: one is by putting the skin on to the foster calf (as with lambs in Britain). But care is needed that the bereaved mother does not see this done, and also that the mother of the living calf does not either. The other two ways of fostering involve force. In one the calf is tied up and laid on the ground in front of its foster mother, and a cord is tied from the calf to the adult's upper lip. This seems to persuade the mother, if she is old and docile, to accept the calf. More obstreperous mothers need harsher treatment. They are tied up with the infliction of considerable pain: some Somalis say that the bonds are so tight as to make the camel faint. The nostrils and ears are tied up, and a clamp (*galaha*) is put on the anus made of two slats of wood. The mother is left like this for several hours, and, on release, is at once presented with a hungry foster calf which she will then accept as her own, because, so the Somalis say, the pain has made her forget. This device is used so that one calf may be used to stimulate lactation in two camels, or, if it is the mother that has died, so that one she-camel may rear two calves.

Although fostering by force saves the trouble of skinning the dead calf, the use of the skin alone seems to be the commonest way of maintaining lactation. During the *Gu* the *gel jirreh* are often seen carrying the *galaha* and a dried skin. The skin is laid before the camel at milking time, and the *galaha* applied for an hour beforehand as an added inducement if it is needed. If the same youth always carries the skin and does the milking, the camel will, in time, give her milk down for him without seeing the skin.

Milking times are just after sunrise and at least two hours after sunset. This late hour allows the camels a rest after the long day's wandering in search of grazing. The calves run with their mothers but are penned separately at night. They start to graze at six weeks old when, if there is labour to spare, they are herded separately and allowed to suck their mothers morning and evening. The Somali is very careful of his young stock, picks ticks off them by hand and watches their progress carefully.

The Riding and Burden Camel. The camel is used less for riding than in the past, but it is by no means rare to see camels ridden in the east. In the west of Somaliland it is less common, and, if a man is seen riding he is

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usually a cripple. A man will go riding with a moving herd of grazing camels but not with a train of burden camels. This is because the nomad has a great respect for both his camels and his cash: he will not ride a camel that already has a burden, nor one that could otherwise earn him cash by carrying a load. The opening of the country to trade trucks taking passengers at a very low rate has reduced the demand for good fast riding camels.

The burden camel is saddled with a soft under-mat and a stiffer one to take the load: mats, loading ropes and leading ropes are all woven in Somaliland by the women from the local plant fibres and grasses. Burden camels take rations from the towns to the nomads; and from the interior they carry hides, skins and ghee for sale in the town. In the west they also carry big loads of sorghum. There are few big commercial burden camel owners: each burden train is made up of the camels of sundry nomads who need cash at the time or who are personally concerned with the goods carried. The camels used are those normally kept for moving house and the work of the *rer*.

The marching times are from three to four o'clock, to eight or nine o'clock in the morning and the same in the afternoon and evening. Between the two marches the camels graze and the camel-men eat and rest. Fifteen to 20 miles is a fair day's march, and the rate of travel depends on the wishes of the camel-men in relation to the state of the country through which they are passing. As the camel walks at just over two miles an hour, marches longer than 20 miles are not easy without hardship to man and beast.

It is the duty of European administrative officers and, of course, veterinary officers to make contact with the nomads by travelling on foot with burden camels in the interior. Somalis are good marching companions for these journeys and see to it that the kit is well loaded so that it rides easily for the camel. They are very cheerful and have work chants for loading and unloading; for example:

> As the girth has cut your belly,
> So the stones of the road will cut my feet,

and

> The camel is tired,
> Take off the load.

Sheep and Goats

The sheep are of the so-called Persian type; white-haired, black-headed, fat-tailed and very hardy. The goats are of the white Galla type often with brown or black patches.

Ownership. Sheep and goats are owned by the women under the nominal authority of the men; but the women have the last word where they are concerned. When a man has more than one wife each has a flock of her own, keeps it in a separate partition of the *rer* at night and grazes it separately by day in charge of her children. The woman gives sheep and goats to her children as they grow up and marry, and may also have to give some to any new wife

her husband may take; but even a strong man may have to use the threat of divorce to make her do so.

Grazing of Sheep and Goats. This work is done either by the women or by the girls and boys from the age of five to 15. The lambs and kids are grazed near home by the youngest children.

Salt and salt grazing are important and provided as for camels.

Sheep live on the grass, and also on its roots: at the end of the dry season it is common to see them scraping the soil with their front feet to get at them. Goats browse on all the vegetation: roots are dug up for them and tree branches cut down for them during a dry time.

Watering. Water is not needed when the grass is green; goats can go longer without it than sheep because of their browsing habits. No matter how dry the grazing, watering is never more often than once a week, and the total time from leaving the pasture to water and back will not exceed three days. The older men do the watering helped by the women. An advance party is not sent and there is less singing at the work.

Breeding and Rearing. Sheep are bred once a year and lamb during the *Gu*. Dates for mating are carefully worked out in the solar year (Hunt, 1948). The ram is kept from mating by the use of the apron, or by running him with the younger sheep and keeping him in a separate place at night. Some out-of-season breeding happens by accident either from the ram or his uncastrated sons. Two per cent of these are kept from each lamb crop and the rest castrated when five months old. The ram himself is castrated when five years old and fattened; the best of his sons then takes over. There is no selection of ewes and they are bred until they reach eight or nine years old.

In a good season a proportion of the ewes may be bred twice by mating them soon after lambing and so getting another lamb crop in the *Dair*. So as not to strain the best animals only second-grade ewes are mated twice. This retrograde trend in selection is compensated for by the longer life of the better ewes. Ewe lambs born in the *Gu* are mated the following Christmas twelve-month, or, more rarely, in the next *Gu* for the *Dair* lambing just mentioned.

Goats are bred indiscriminately, starting when the female is two years old. Her breeding life is a bit longer than the ewe's and she usually has two kids a year. The billy-goat is not castrated and replaced: young male goats not for breeding are castrated with the young rams.

The lactation period of both sheep and goats is five months. Lambs and kids are weaned completely by this time to avoid impairing the condition of their mothers. The teats may be smeared and occluded with the latext from *Euphorbia spinecsens Pax.* (*dirinder*) if milk is still being secreted at five months. Women and girls do the milking at dawn and dusk.

Cattle

Cattle are of Zebu type and variable in size and colour. There are a few herds of truly nomadic cattle in the south-east. These are small with short horns and their relationship to the *rer* and the family is much the same as with

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camels, except that they have to be watered every second day irrespective of season. In the west the cattle are used for the plough (Fig. 5), they are larger and inter-bred with the lyre-horned Ankole-zebus of Ethiopia. During the dry season they are fed on the stems of the harvested sorghum and do not as a rule go so far away from the *rer* as the camels.

Ownership of cattle is intermediate between that state of affairs existing for camels and that for sheep and goats. Nomad cattle are the concern and property of the men, but in the west, because the women do their share of the milking and all the marketing of the milk, they have a big say in the care of the cows and in their disposal.

The calves are grazed by the youngest children, and the adult herd by older girls, youths or men. Cattle herders (*loh jirreh*) are a less specialised class than the *gel jirreh*. Watering is done by the men every second day.

Breeding is indiscriminate, but the climate ensures that most calves are born in the *Gu*. Selective breeding is practiced by a very small minority of Somalis. Males are castrated late in life, if at all, so that they develop a good neck for the plough: no consideration is given to producing a fat beast for slaughter because Somalis rarely eat beef. Counts of sample herds in the west showed a quarter of the stock to be adult bulls for ploughing, a quarter adult milking cows, and the rest young of both sexes. The standard of cattle management is below that for camels.

Lactation lasts about eight months: once the cow is in calf she goes dry. If the calf dies its skin is mounted on a frame and used to keep the mother in milk: it may be put on a foster calf as with sheep and camels.

Horses, Mules and Donkeys

The Somali pony is a sturdy animal of from 13 to 14 hands. The best come from the east: those in the west have inferior conformation and feet.

Little interest is taken in horse breeding to-day because the country is now too barren to allow the use of ponies, as in the past, for scouting for fresh grazing or for stock raiding. They are allowed to run wild and to breed as they will. The Gerad, or chief, of the Warsengeli tribe in the east still owns good ponies, and the odd sheik or sultan may carry on a line in a small way. Fifty years ago, however, every tribe except the Esa bred ponies in large numbers (Swayne, 1895). Now it is rare to see a mounted Somali except in farm areas.

Mules are not bred but a few are imported from Ethiopia for use in the west.

Donkeys of a good uniform type are commonly bred even in the interior and used mainly in the towns for carrying meat, water or building materials.

Ponies and donkeys are not castrated as routine, but only if they make nuisances of themselves.

Castration of Animals

Castration by striking the cord is used for sheep, goats and cattle. Sheep and goats are done in the sitting position by striking the cord lightly for 15 minutes. The cord is laid over a flat piece of wood and struck with a light

mallet made from a naturally shaped branch. For bulls an ordinary hammer and a flat piece of iron are used in the cast position.

Castration with the knife is more commonly used for bulls, and always for camels, ponies and donkeys. The arteries are occluded by torsion, but, if bleeding is excessive, the wound is plugged with the unwashed root of *Chrysopogon aucheri Stapf.* (*daremo*), a grass credited with special hæmostatic properties. Somali castrators seen at work with the knife have been very competent.

Castration by destroying the testicular substance with a red hot needle is sometimes used for sheep and goats. The right of using this method is said to be vested in barren women.

Cattle and horses, and sometimes camels, are cast for castration by a method similar to that of Reuff: the rope is taken for a turn round the hind fetlocks after the last half-hitch round the body. If a pony is very wild it will be put down by lunging it on a noosed rope until it is exhausted and then pulling it over and securing it. Camels are usually barracked down as for loading, the legs tied in the bent positions and the beast then rolled over. Castration of large animals is never attempted standing.

It may be added that Somalis in the Veterinary Department are using the Burdizzo castrators more and more often at the request of the people, and that they are getting good results even on camels and ponies.

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ARTIFICIAL INSEMINATION OF A BITCH WITH PRESERVED SEMEN

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Introduction

ARTIFICIAL insemination has been resorted to in dogs only when natural matings have been impossible due to some physiological or psychological reason, or possibly for research purposes.

Up to the present it has been subject to a form of natural control, in that the difficulty of preserving the semen for any length of time has limited the widespread dissemination of semen from a particular stud.

During the course of certain investigational work in this Department, this last obstacle has now been overcome, and the following is a report of a successful pregnancy obtained by artificial insemination using semen that had been preserved one hundred hours.

Technique

(a) *Collection of the semen*

Semen was collected in fractions from a Greyhound dog "Fawn" on the morning of May 8, 1954, by means of a canine artificial vagina (Harrop, 1954). The second fraction of the ejaculate—the sperm-containing fraction—was examined microscopically immediately, and recorded as a very good sample (Fig. 1).

(b) *Preservation of the semen*

The sample of semen—about 2 c.c.—was added to 14 c.c. of pasteurised milk which had been treated in the following manner. A bottle of pasteurised milk was purchased at a nearby dairy, and about 50 c.c. was put into a shallow beaker and heated slowly up to 92° to 94° C. It was kept at this temperature for ten minutes and then allowed to cool to room temperature. When cool the scum was removed by decanting gently a sufficient quantity of the milk into a test-tube (Thacker and Almquist, 1953).

The semen, which was now diluted 1.8, was placed in a cold room at 4° C.

(c) *Insemination*

On the afternoon of May 12, 1954, 4 c.c. of this preserved semen was injected directly into the uterus of a maiden Greyhound bitch "Nina," who was at her twelfth day of œstrous.

The inseminating apparatus was very simple, and consisted of an ordinary 1 ml. glass pipette, a glass syringe—with a rubber tubing adapter to the pipette, and a vaginal speculum which was made by blowing a small hole in the end of a 6 in. x $\frac{5}{8}$ in. test-tube, sufficient to allow passage of the pipette (Fig 2).

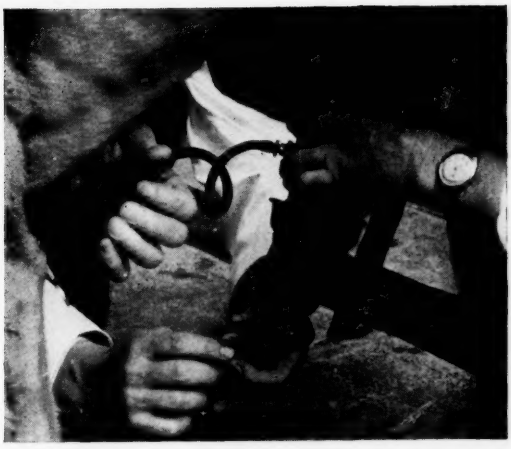

Fig. 1
Collecting the second fraction of the ejaculate by artificial vagina.

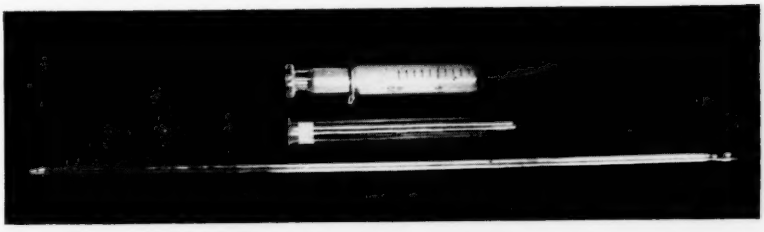

Fig. 2
Simple inseminating kit.

Fig. 3
"Nina" and her two puppies.
(*Article by Harrop, page* 424)

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The bitch was placed on a table of convenient height, held by an assistant, and the external gentalia thoroughly washed and dried. The speculum, lightly lubricated, was then inserted, and the cervix located with the aid of a torch. The pipette was pushed through the speculum and placed directly through the cervical-os. The glass syringe containing 4 c.c. of the diluted semen was now connected to the pipette by means of the rubber tubing and the semen injected directly into the uterus.

It was not deemed necessary to raise the hindquarters of the bitch during insemination, for the semen had been placed directly into the uterus.

Pregnancy was diagnosed clinically by palpation on June 7, and confirmed by X-ray picture on June 24.

The bitch whelped two healthy male puppies on July 15, after an uneventful 64-day pregnancy (Fig 3).

Discussion

This record is important as it is the first time that canine semen has been preserved for any length of time and been proved capable of fertilising a bitch.

It also opens up the possibilities of artificial insemination of bitches under the following circumstances:—

(*a*) When a natural mating cannot be consumated.

(*b*) To replace natural mating when this is impossible due to geographical distance between stud and bitch.

(*c*) Increasing and extending the usefulness of valuable proved studs.

(*d*) As a possible aid in disease control.

Summary

Using an artificial vagina semen was collected from a dog, the sample being preserved in pasteurised milk. The successful production of pregnancy in a bitch by artificial insemination with preserved semen has been accomplished. The possibilities of artificial insemination in dogs are discussed.

Acknowledgments

I wish to thank Professor N. J. Scorgie for his helpful advice and criticism, and J. M. Larkin for his technical assistance and photography.

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STUDIES ON BRACKEN POISONING IN CATTLE—PART III
Field Outbreaks of Bovine Bracken Poisoning

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1. *The Ty-Coch outbreak.*

In the late summer of 1950, through the courtesy of Mr. McNaught, M.R.C.V.S. (Chepstow), and Mr. Allen, M.R.C.V.S. (V.I.O., South Wales Province), access was obtained to a very severe outbreak which occurred in a bunch of pedigree Friesian heifers at Ty-Coch, Llantarnam, Monmouthshire. The history and outcome of this outbreak is instructive; in all, 22 heifers died of bracken poisoning.

The heifers had been out on hill grazings (with access to bracken) since early April; they were in fair condition, but keep was short. They were kept there for a month, and then brought down from the hill to good grazing (bracken free), for three weeks. They were then sent back to the hill farm, along with some other animals in very good condition. At the end of June, when they were tuberculin-tested, it was noticed that three were in a very poor condition, and these were brought down to the home farm; one died in July and the other two improved, and were turned back with the others on the hill. The lot was brought down at the end of August. Deaths occurred during the early part of September, but went on at less frequent intervals into October; the last death occurred on October 17, i.e., about seven to eight weeks *after* any direct access to bracken.

The following symptoms were apparent in all, hæmorrhages from the nose and anus, preceded or followed by a rapid loss in condition. None of the in-calvers, although out with the other heifers, died. The condition of the cattle going up to the hill seemed to bear little relation to their subsequent fate. Aneurin therapy (100 mg. B_1 by injection per day) had no favourable effect on the poisoned animals. The farm was visited on October 4, 1950, just in time to witness the death of one of the heifers. There were two more heifers showing definite symptoms, as follows:—

Animal No. 1—a well-built blue-grey heifer, in fairly good condition. Rectal temperature 105° F., bleeding from nostrils and rectum. Petechiæ on vulva and conjunctivæ.

Animal No. 2—a young Friesian heifer, in poor condition. Rectal temperature 107° F., bleeding profusely from nose. Fæces contained blood clots. Numerous petechiæ on mucous membranes. Appeared a very acute case.

Animals
Nos. 3 and 4—appeared to have a slightly elevated temperature, but no other symptoms.

* Now at the Veterinary School, Cambridge.

Treatments

October 4. Aneurin 100 mg. by injection to Nos. 1 and 2. The two animals were also transfused with two pints each of fresh citrated blood, taken from the milking herd. On the same evening, animal No. 2 showed symptoms of shock, increased respiration, shivering, etc.

October 5. No. 1 eating hay and dairy nuts quite well. Rectal temperature 105° F. No. 2 had overcome the shock symptoms, but temperature still 107° F.; off her food. Transfused this animal with a further three pints of fresh glucose-citrated blood.

October 6. No. 1 still had a temperature of 105° F. and was passing fairly large blood clots in fæces. Injected subcutaneously with a solution of 200 mg. B_1, 500 mg. Ascorbic acid, and 20 mg. Vitamin K (synkavit). No. 2—nasal bleeding had stopped; the petechiæ on the mucous membrane were not so prominent. Temperature 105° F. Gave a further two pints of blood to this animal and the same vitamin therapy as No. 1 above.

October 7. Transfused both animals with two pints of fresh blood each; also repeated the same vitamin therapy. No. 2 was very ill and recumbent, with a temperature of 106° F. Temperature of No. 1 had risen to 107° F.

October 8. No. 2 died.
No. 1, temperature 108° F. and bleeding from nostrils, with petechiæ on mucous membranes.

October 9. No. 1 died.

Both animals were recumbent before death, the head being turned round as though the animals had acute abdominal pain. A post-mortem examination on both animals showed the usual picture of extensive hæmorrhages.

Table 10 records some observations on these animals on October 4 and 7.

TABLE 10.

Observations on the naturally occuring outbreak of bracken poisoning at "Ty-Coch" Farm, Llantarnam, Mon.

Date	4/10/50				7/10/50	
Animal No.	1.	2.	3.	4.	1.	2.
R.B.C. ($x10^6$/cmm.)	4.9	4.0	5.2	6.7	3.3	2.5
W.B.C. ($x10^3$/cmm.)	3.2	1.7	2.2	6.1	1.3	0.45
Polymorphs. (%)	1.0	—	18.0	8.5	—	—
Platelets ($x10^5$/cmm.)	6.5	1.5	1.8	6.0	1.0	0.83
Bleeding time (mins.)	4.5	30.0	3.0	3.0	45.0	unable to bleed
Coagulation time (mins.) ...	3.5	17.0	6.0	6.5	16.5	12.0
Prothrombin time (secs.) ...	20.0	25.0	23.0	20.0	25.0	33.5
Fluid Vol. of Clot (%, 18 hours)	54.5	57.5	55.3	13.0	65.0	66.0
Rectal temperature (° F.) ...	105.0	107.0	103.0	103.0	107.0	106.0
Blood Pyruvate (mg. %) ...	2.0	2.0	2.0	2.5	—	—
Petechiæ	++	++	—	—	++	++
	Died	Died	Died	Survived		

2. *The Glyntwymyn outbreak.*

This outbreak involved fifteen cattle grazing bracken-infested hill land and was investigated during the summer of 1951, at Glyntwymyn farm, Montgomeryshire. Three animals had already succumbed, showing typical lesions of bracken poisoning, and Table 11 records observations made on the remaining twelve animals. Three of these died within a week of the first visit to the farm. Some

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of the remaining animals showed abnormally low leucocyte counts, whilst initially, others showed values falling within the accepted normal range (8,000 ± 2,000 per cmm.—Holman). However, these latter animals subsequently developed marked diminutions in their white cell counts which was followed by a slow recovery. They were still below normal even as late as December, 1951. They also developed a thrombocytopenia which was corrected within a similar period. Figure 7 illustrates the sequence of events which occurred in the blood elements of one of these animals during the recovery period.

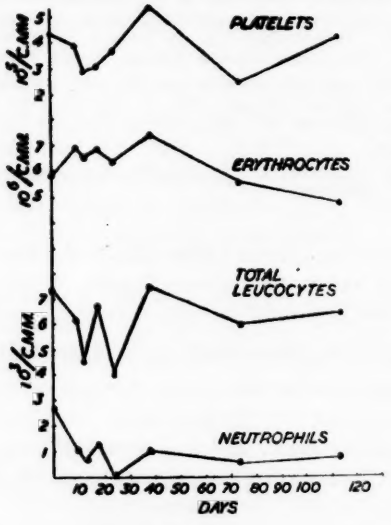

FIG. 7

Glyntwymyn Outbreak of Bovine Bracken Poisoning; the sequence of hæmatological events in an animal that recovered.

The observations on these two naturally occurring outbreaks of bracken poisoning in cattle amply confirm the hæmatological abnormalities seen in our experimentally produced cases of bracken poisoning.

Discussion

This work has confirmed the results of previous investigators (e.g., Stockman, Hagan, etc.) that green bracken if eaten in some quantity is toxic to livestock. Experimentally produced bracken poisoning, through the feeding of a 50 per cent mixture of air-dried bracken and hay to cattle, develops within 30 to 80 days. We believe that the ingestion of fresh green bracken could produce the acute condition more rapidly. It does not seem that the previous nutritional state of the animal has a bearing on the readiness with which it succumbs to the toxic effects of bracken. All breeds of cattle tested were susceptible under experimental conditions, although there may be variations under natural conditions, due to selective grazing habits.

TABLE 11.

Observations on the naturally occurring outbreak of bracken poisoning at "Glyntwymyn," Montgomeryshire, 28.8.51.

Animal	R.B.C. ($x10^6$ /cmm.)	W.B.C. ($x10^3$ /cmm.)	Polymorphs %	Platelets ($x10^5$ /cmm.)	P.C.V. (%)	Clotting time (mins.)	Temp. (° F.)	Other observations	
Stalin	3.1	1.8	1.0	0.73	15.0	14.0	107.4	Petechiæ and hæmorrhage from nostril.	Died.
Daffodil	7.0	3.9	16.0	1.3	29.0	8.0	102.4	—	Survived.
Blanche* ...	5.9	7.4	27.0	4.3	26.5	6.0	104.0	Pneumonic area on left lung.	Survived.
Panto*	7.2	8.5	14.0	5.0	30.0	4.5	101.0	—	Survived.
Edward	7.4	4.6	23.0	1.1	32.0	5.0	—	—	Survived.
Daisy Belle ...	7.0	3.8	5.0	2.1	32.0	6.0	—	—	Survived.
Anthony ...	5.9	4.0	12.0	3.8	27.0	5.0	102.4	—	Died.
Bruce Woodcock	6.2	7.1	18.5	2.3	30.0	6.0	103.2	—	Survived.
Jack	5.7	3.8	9.0	1.8	29.0	5.0	103.0	—	Died.
Gwladys ...	5.2	3.9	6.0	1.3	33.0	3.0	103.0	—	Survived.
Millicent ...	6.7	8.4	23.0	3.0	31.0	5.0	103.0	—	Survived.
Percy	6.1	8.6	25 0	2.7	34.0	6.0	—	—	Survived.

* Blood samples taken on 28.8.51.

The consistent findings of a leucopenia and thrombocytopenia in this cattle disease has afforded a rational basis to a better understanding of its pathology. Initially the bone-marrow is damaged, and the feeding of bracken to cattle leads in some unknown manner to a depression in the activity of myeloid and megakaryocyte tissue. It is evident from our results that the leucocyte and platelet elements in the blood become depressed to abnormally low levels before any marked effects on the erythrocytes are observed. This situation is reflected in the prevenient effects on the bone-marrow, which are much more severe on the granulocytic and thrombocytic series than on the erythrocytic series, although the latter becomes affected in the terminal stages of the disease.

Current information regarding the life-span of the various cellular elements in the blood may possibly explain why some cells are affected numerically before others. The average life of a circulating red cell is a hundred and twenty days, as measured by the decay in the activity of glycine labelled with N^{15} incorporated into the hæmin of the cell (58). Recent studies on the life-span of leucocytes give values of fourteen days, as measured by the decay in radioactive phosphorus incorporated into the desoxy-ribose-nucleic acid of white cells (59). This figure represents an average for the various white cell types, and is a composite of at least two components, the lymphocytes and neutrophils. Reliable information regarding platelet production and viability are much more difficult to obtain. It has been stated that the entire number of platelets in the circulation can be replaced in three to five days (60). Experiments on the survival of human blood platelets in vitro, as measured by their ability to produce clot retraction, indicate that at 37° C. clot retraction was good after 48 hours, but no longer occurred after the third day (61). The hæmatological findings at any one time, of course, are the resultant of a balance, between rate of production of various cells, the time they take to reach the circulating blood, and their rate of removal or destruction. Each of these factors may be subject to very wide fluctuations.

The dominant clinical features of bracken poisoning in cattle were known to be hæmorrhages and high fever; a leucopenia, thrombocytopenia, defective clot retraction, and increased capillary fragility is now demonstrated in this condition. Defective capillary function is probably the major cause of hæmorrhage in thrombocytopenic states in man, according to Macfarlane (62). The origin of the high fever is uncertain. In man, gross reduction in granular leucocytes leads to an illness, one of whose terminal features is bacterial invasion of the blood stream. There is no evidence, however, that such organisms are to be regarded other than as secondary invaders. In cattle bracken poisoning a high temperature is present, although blood cultures may be sterile; such evidence as we have obtained does not support the theory that the fever is due to a septicæmia. In the terminal phase of the disease, when the resistance has been lowered by the absence of granulocytes, and hæmorrhagic foci have become extensive due to platelet deficiency, infection may occur readily with the extreme rapidity to be expected in defenceless tissues. It is possible that peripheral circulation is reduced with a consequent disturbance in the skin mechanism for regulating temperature—the pyrexia could be due to such a cause rather than a bacteræmia.

The nature of the mechanism producing the marrow hypoplasia is speculative, although certain possibilities have been excluded, and others are rendered more probable. Bone-marrow damage in other species, leading to agranulocytosis and thrombocytopenia, may be brought about by a large variety of chemicals, unrelated from the structural point of view, as well as by physical agents, such as ionising radiations (see Dameshek [63] or Wintrobe [51]). A deficiency of certain members of the vitamin B complex is also known to lead to hypofunction of the blood-forming tissues (51, 64).

Any theory of the ætiology of bracken poisoning must at the present stage of knowledge be compatible with the following facts:—

(*A*) Simple "stomached" animals, e.g., the rat, and horse suffering from the effects of bracken, present a picture of an avitaminosis (B_1). After treatment with aneurin, the animals recover. The rat may be maintained on a bracken diet for several months, provided aneurin is supplied, and without any untoward effect (65). Similar experiments, of long duration, have not been conducted, to our knowledge, on the horse. The blood showed a thrombocytopenia and a leucocytosis in field cases of bracken staggers in the horse (14), which disappeared as the animals recovered, following correction of the avitaminosis (B_1).

Lutwak-Mann (66), has shown that the bone-marrow of aneurin-deficient rats had markedly low nucleic acid content; this is a good indication of a decrease in the cellularity of the tissue. Jones, Thomas and Evans (67) made a study of the alkaline phosphatase, ribose and desoxyribose-nucleic acid in the bone-marrow of rats fed on aneurin-deficient semi-synthetic diet, a 40 per cent active bracken diet, and a similar diet with the bracken autoclaved. The results will be reported elsewhere; they confirm Lutwak-Mann's findings that there is a hypoplasia of the bone-marrow in avitaminosis B_1, the bracken-fed rats showing these effects in a more acute form, whilst autoclaving the plant abolished them. In our experience with the rat fed on a bracken diet, the animal dies of aneurin deficiency, before the consequences of a circulating leucopenia and thrombocytopenia becomes acute. Similarly, horse bracken staggers is the result of an avitaminosis B_1, although abnormalities in the platelet and possibly leucocyte elements begin to appear. Naftalin and Cushnie (38) have reported severe damage to the bone-marrow affecting both the myeloid cells which give rise to the granular leucocytes of the peripheral blood, and the megakaryocytes which give rise to the thrombocytes in bracken-poisoned rats. Cordy (68) has reported that rats on a ration containing raw bracken showed thrombocytopenia, some leucopenia, and a marked bone-marrow hypoplasia; rats fed on an autoclaved fern ration showed none of these abnormalities. Both groups of investigators mention that aneurin therapy promptly corrected or prevented these changes. The presence of thiaminase in bracken accounts for the development of an avitaminosis (B_1) in those animals which require a supply of aneurin in the diet; for the rat, therefore, there is no difference, except of degree, between an aneurin-deficient diet and a bracken diet. In cattle bracken poisoning whilst there is a hypoplasia of the bone-marrow, there is no avitaminosis (B_1). Aneurin therapy, given parenterally, or by mouth in appreciable quantities during the

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whole period of feeding on the bracken diet, is unable to prevent or reverse the kind of damage incurred on the myeloid tissue of cattle. We might infer from these considerations that the mechanism causing the cattle bone-marrow damage is different; further, that the agent bringing it about shows a species specificity, being innocuous to the rat.

(*B*) Steaming bracken for about one hour renders it incapable of producing bracken poisoning in cattle. The enzyme thiaminase is inactivated by this procedure, but there need not be necessarily a connection between these two phenomena. There could be another agent in bracken, responsible for the bone-marrow hypoplasia in ruminants, which is unstable or volatile under the steaming conditions. The dominance of leucopenia and thrombocytopenia, with an absence of avitaminosis (B_1), seems to be characteristic of the effect of bracken on cattle. Moon and Raafat (69, 70) have produced bracken poisoning in sheep; they state that the symptoms and post-mortem findings were similar to the condition in cattle. Recently Moon and McKeand (71) have observed a leucopenia, some indication of platelet deficiency, and a progressive fall in erythrocytes and hæmoglobin in bracken poisoning in sheep. They do not give hæmatological results until the sheep had been on the bracken diet for 132 days. The prolonged period of bracken feeding (288 days) found necessary before the sheep succumbed to bracken poisoning might have been responsible for this additional feature of the hæmatology in this species. In unpublished work, we can confirm the observation that sheep are much more resistant than cattle to the toxic effects of bracken.

Although we have not made a special study of rumen flora in cattle bracken poisoning, we have satisfied ourselves that there is no dramatic reduction in bacterial counts, or any change in the nature of the protozoa in the rumen ingesta. It is important to remember that the ruminant derives its energy mainly from volatile fatty acids, as a result of bacterial action in the rumen. Conditions in the rumen (*pH*, temperature, presence of ample co-factors) are favourable to thiaminase action. Any extracellular aneurin or co-carboxylase would be split to their respective pyrimidine and thiazole components. Most micro-organisms, however, are able to utilise these parts for aneurin synthesis within the cell. It is difficult to conceive that thiaminase, being a protein, could penetrate microbial cells; the micro-organisms in the rumen would, therefore, have their normal complement of this vitamin and its biochemically important derivatives, even in an animal on a bracken diet. It is also probable that a considerable destruction of thiaminase occurs in the rumen under the influence of microbial proteolytic enzymes. In any event, as the rumen organisms reach the abomasum, the environment for thiaminase action becomes unfavourable, because of the acid conditions (the isoelectric point of the apo-enzyme part of thiaminase is approximately *pH* 3). Autolysis and digestion of rumen organisms would still proceed in the true stomach, with consequent liberation of aneurin presumably in adequate amounts for the needs of the animal. It is therefore possible to understand why there is no gross aneurin deficiency in cattle suffering from bracken poisoning. It is still possible that some, as yet unrecognised action of

thiaminase on the biochemical events occurring within the rumen, produces an agent causing the bone-marrow damage, e.g., a vitamin antagonist or anti-metabolite.

(*C*) The bovine bone-marrow lesions are not due to a direct nutritional deficiency of any of the known vitamins essential for the normal functioning of myeloid tissue. The following have been given in adequate doses parenterally to cattle during the whole period of bracken feeding: aneurin, riboflavin, nicotinamide, pantothenic acid, pyridoxine, choline, inositol, folic acid, ascorbic acid; together with a liver preparation (containing vitamin B_{12} and biotin), and synthetic vitamin K (synkavit) after the onset of clinical symptoms. More recently, one of us (72) has administered aneurin, folinic acid (leucovorin), and cobalamine (vitamin B_{12}) parenterally, every day from the start of bracken feeding to a heifer without affecting in any way the course of the disease. The animal died of bracken poisoning within a few days of its control, which was on the same diet but untreated. In both cases the diet maintained the animals in fairly good condition until they succumbed.

Similarly, animals receiving a bracken ration plus a small amount of dried yeast daily (60 gms.) also developed the disease, as well as those receiving molasses with bracken. In the Ty-Coch outbreak we tried repeated small-scale blood transfusions without any dramatic results; possibly large-scale fresh blood transfusions (a gallon at a time) might prolong life in a case of cattle bracken poisoning, sufficient to allow an opportunity for adequate resumption of bone-marrow function—assuming that the marrow damage is reversible at this stage.

Finally, antibiotic therapy (procaine-penicillin, and terramycin) and chemotherapeutic measures (sulphamethazine) given intravenously, to control possible secondary infections as the leucopenia became acute, did not affect the final outcome (72).

We have been struck with the close resemblance between the symptoms and lesions in bracken poisoning in cattle and a disease produced in cattle by the feeding of soya-bean meal defatted with trichlorethylene, first investigated by Stockman (73) in 1916. This acute observer described both conditions as an intoxication, with similar clinical symptoms. Recently, Pritchard, Rehfeld, and Sautter (74) have investigated Tri-Chlorethylene-Extracted Soya-bean Oil Meal poisoning in cattle (variously called Stockman, Duren or Brabant disease) and have shown it to be an aplastic anæmia. One point of difference, perhaps of degree only, is the pronounced depressing effect on the erythrocytic, as well as the granulocytic and thrombocytic series in TCESOM poisoning, whereas in bracken poisoning the granulocytic and thrombocytic series only appear to be aplastic. The causative agent in TCESOM poisoning has not been elucidated, but it appears to be due to the bone-marrow depressant properties of a product of interaction between this particular solvent (or its decomposition products) on some constituent of the soya-bean. A significant observation of Pritchard, *et al.* (private communication, July 8, 1953), is the species susceptibility to TCESOM poisoning. Cattle, horses and sheep show aplastic anæmia; guinea pigs a chronic wasting disease but no aplastic anæmia; chickens, turkeys, swine, rats, mice,

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hamsters and goats are not markedly affected, except perhaps the rates of gain of some lots are less than their controls.

Confusion can and does arise in arriving at a differential diagnosis between bracken poisoning and other purpuric conditions in cattle, e.g., TCESOM poisoning, hæmorrhagic septicæmia, salmonellosis, anaplasmosis, acute pneumonia or "shipping fever," bovine leptospirosis, Crotalaria poisoning, sweet clover poisoning, and bacillary hæmoglobinuria. Some of these are discussed by Sippel (41) to whom reference should be made for points of distinction between these various diseases. To these must be added a bovine thrombocytopenic purpura of unknown origin recently met with by Evans (75).

Bracken poisoning of cattle is probably caused by *either* a heat labile or volatile chemical present in raw or air-dried green bracken, *or* to a substance formed subsequently in the rumen by the interaction of active (but not steamed) bracken and rumen contents—e.g., a vitamin antagonist or antimetabolite, which has a toxic action on the bone-marrow of this species. In our opinion, it is the extent of the bone-marrow damage which determines whether recovery is possible or not; if this has reached an irreversible stage, no therapy at present known is likely to be successful. The fact that some cattle get better after developing recognisable symptoms suggests that at a certain stage the bone-marrow is capable of recovery, although extremely slowly, as demonstrated by some of the cattle that eventually got better in the Glyntwymyn outbreak. Therapeutic measures are dependent on a knowledge of the chemical nature of the causative agent, together with a precise understanding of its biochemical mode of action on the bone-marrow. The relatively specific effects of the bracken factor on myeloid tissue raises the possibility that it might, when isolated, be of interest in a wider context than the one discussed in this paper. Experiments are continuing towards these ends.

Summary

(1) Investigations on experimentally produced bracken poisoning in calves and older cattle are described; the results obtained were corroborated by similar findings from two natural field outbreaks of bracken poisoning in cattle.

(2) The disease was characterised in all cases by the familiar hæmorrhagic syndrome with terminal pyrexia.

(3) A leucopenia and thrombocytopenia were constant hæmatological features in cattle suffering from bracken poisoning. There was increased capillary fragility, a prolonged bleeding time, and defective clot-retraction; the clotting and prothrombin times were not grossly affected.

(4) Sternal marrow biopsies revealed aplasia of the granulocytic and thrombocytic with, on occasions, hypoplasia of the erythrocytic series of the bone-marrow.

(5) There was, in this condition, no close correlation between positive blood cultures and the presence of fever.

(6) The tissues of cattle suffering from bracken poisoning were not unduly deficient in their aneurin content, i.e., there was no evidence of an avitaminosis (B_1), in animals dying from the disease.

(7) Blood pyruvic acid levels remained normal during the production of bracken poisoning until the day before death, when there was a precipitous rise in the blood level of this acid, reflecting possibly a starvation ketosis.

(8) Steaming green active bracken for an hour rendered it incapable of producing bracken poisoning in cattle; after this treatment it was innocuous to the animal.

(9) All attempts at therapy in clinically diagnosable cases of bracken poisoning in cattle were unsuccessful. These included:—

(*a*) Administration of aneurin, riboflavin, nicotinamide, pantothenic acid, pyridoxin, folic acid, leucovorin, biotin, vitamin B_{12}, choline, ascorbic acid and vitamin K.

(*b*) Small-scale fresh blood transfusions.

(c) Antibiotic therapy (procaine-penicillin and terramycin) and chemotherapy (sulphamethazine) intravenously.

The administration of the above "vitamin B-complex" group of factors parenterally from the beginning of bracken feeding did not prevent the condition from developing.

(10) The fundamental lesion in bovine bracken poisoning is the depression of bone-marrow activity. The mechanism by which this is brought about remains uncertain. Fresh or air-dried green bracken is capable of producing the condition; on steaming the plant this property is lost.

The following possibilities seem worthy of further consideration:—

(*a*) Bracken may contain a hitherto unidentified, heat-labile or volatile substance, with a direct toxic action on the bone-marrow of cattle.

(*b*) Such a chemical may have to undergo modification in the rumen for the actual toxic agent to be produced.

(*c*) A thermo-labile factor in bracken, e.g., an enzyme, may interact with substances produced in the rumen, to give a chemical with bone-marrow depressant properties, e.g., a vitamin antagonist or an antimetabolite. The aneurin destroying property of thiaminase does not seem to be directly involved in the cattle condition, since there is no avitaminosis (B_1). The participation of reaction products of this system, however, have not been definitely excluded.

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XUM

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APPENDIX 1

1949 Bracken Poisoning Experiment.
(Cwmwythig Farm.)

Date.	Animal No.	R.B.C. (x10⁶/cmm.)	Hb. (g.%.)	W.B.C. (x10³/cmm.)	P.C.V. (%)	S.G. (Blood)	S.G. (Plasma)	Blood Pyruvate (mg.%.)
19/9/49	1	7.0	11.5	9.8	34	1.052	1.026	1.5
	2	7.3	9.9	8.8	34	1.051	1.026	1.0
	3	8.7	9.5	10.6	34	1.051	1.027	1.3
	4	8.5	10.2	8.9	36	1.051	1.028	0.8
	5	8.4	10.4	12.0	42	1.051	1.028	1.0
	6	7.0	10.9	10.6	35	1.052	1.028	0.8
26/9/	1	8.2	10.8	8.7	39	1.051	1.028	0.3
	2	7.4	9.9	11.5	38	1.049	1.026	0.3
	3	8.2	10.2	5.6	37	1.049	1.027	0.3
	4	6.5	10.9	7.3	37	1.051	1.027	0.3
	5	7.5	9.9	14.5	42	1.051	1.029	0.3
	6	7.1	9.1	8.0	42	1.049	1.024	0.5
17/10/	1	6.3	9.9	8.0	37	1.048	1.026	2.1
	2	5.7	8.9	7.5	33	1.048	1.026	2.4
	3	5.6	8.5	2.0	32	1.045	1.026	2.1
	4	6.8	8.5	3.0	34	1.045	1.024	2.5
	5	7.5	8.5	10.0	36	1.048	1.025	2.8
	6	6.6	9.9	9.2	34	1.046	1.029	-
24/10/	1	4.0	7.0	3.0	24	1.048	1.027	5.1
	2	6.2	9.1	6.8	35	1.053	1.028	2.8
	3	6.0	6.8	3.4	24	1.047	1.030	3.3
	4	7.9	8.9	3.8	35	1.052	1.031	3.0
	5	6.1	9.1	3.8	35	1.052	1.031	2.9
	6	8.3	9.0	5.6	36	1.054	1.028	3.0
25/10/	1*	4.7	6.8	2.5	27	1.044	1.028	3.0
31/10/	2	6.2	8.3	6.6	33	1.049	1.028	2.0
	3	6.9	6.8	2.0	26	1.043	1.023	2.5
	4	6.5	7.6	5.8	33	1.045	1.027	1.8
	5	8.7	7.8	8.4	34	1.047	1.025	1.5
	6	8.2	7.7	6.0	34	1.046	1.023	2.0
1/11/	3*	4.5	6.3	1.0	23	1.039	1.026	2.9
7/11/	2	7.1	7.1	3.4	30	1.046	1.026	2.2
	4*	3.0	6.0	1.8	18	1.044	1.028	4.9
	5	8.2	7.7	6.2	36	1.048	1.026	1.0
	6	8.2	9.1	6.0	52	1.046	1.029	1.1
13/11/	2	6.1	6.2	1.5	26	1.041	1.026	2.4
14/11/	2*	3.3	3.4	0.6	14	1.032	1.023	2.8
	5	5.7	8.1	12.6	35	1.045	1.025	0.8
	6	7.8	8.8	6.6	39	1.047	1.025	1.1
9/12/	5	7.2	8.4	7.0	34	1.047	1.026	1.9
	6	7.6	8.9	11.2	35	1.048	1.024	1.4

* Denotes death of the animal on this day.

APPENDIX 2

1949-50 Bracken Poisoning Experiments (Calves)
(Cwmwythig Farm.)

Date.	Animal No.	R.B.C. (x10⁶/cmm.)	Hb. (g.%.)	W.B.C. (x10³/cmm.)	P.C.V. (%)	Sp.G. (Blood)	Sp.G. (Plasma)	Blood Pyruvate (mg.%.)
19/9/49	7	9.4	11.6	9.1	41	1.053	1.028	1.5
	8	8.1	10.9	11.2	38	1.053	1.028	1.3
26/9/	7	7.3	10.8	12.0	46	1.051	1.025	1.0
	8	8.1	11.1	7.1	45	1.052	1.026	1.5
4/10/	7	10.5	9.2	4.0	46	1.054	1.027	4.0
	8	10.0	8.6	4.0	44	1.055	1.029	4.0
5/10/	7*	10.8	9.3	2.6	47	1.058	1.028	4.4
	8	9.5	7.7	3.0	36	1.053	1.029	4.8
6/10/	8	9.4	8.2	3.0	39	1.051	1.027	3.8
7/10/	8*	9.7	8.7	0.7	40	1.051	1.027	4.3
17/10/	7A	7.1	8.5	8.6	32	1.052	1.025	2.4
	8A	8.2	9.0	8.6	35	1.046	1.025	2.5
	9	9.3	9.8	8.5	43	1.051	1.026	2.4
21/10/	7A	8.2	10.7	5.6	48	1.058	1.027	2.5
	8A	6.3	10.5	7.3	41	1.056	1.032	2.6
	9	7.5	9.9	2.4	42	1.056	1.028	2.6
31/10/	7A	8.5	9.8	6.0	49	1.052	1.024	1.5
	8A	8.8	8.9	5.1	35	1.045	1.025	1.5
	9	7.0	11.5	8.8	42	1.051	1.026	1.8
3/11/	7A*	9.0	11.8	9.4	53	1.054	1.026	-
7/11/	8A	8.6	7.7	7.8	39	1.047	1.027	1.7
	9	8.5	10.4	4.0	44	1.052	1.026	1.5
	10	8.8	11.2	5.4	37	1.058	1.026	1.2
13/11/	9*	9.1	10.4	8.2	52	1.053	1.056	2.0
14/11/	8A	6.6	7.8	5.4	35	1.045	1.025	-
21/11/	8A	6.3	7.0	4.6	31	1.044	1.028	2.2
	10	9.3	10.9	8.6	56	1.057	1.026	2.2
28/11/	8A	8.0	7.8	7.2	29	1.045	1.025	2.0
	10	9.5	10.7	8.2	54	1.056	1.026	1.3
7/12/	8A*	7.1	6.4	5.0	24	1.043	1.028	-
12/12/	10*	-	-	-	-	-	-	-

* Denotes death of the animal on this day.

APPENDIX 3

1950 Bracken Poisoning Experiment.
(Lluest Farm.)

Date.	Animal No.	R.B.C. ($x10^6$/cmm.)	Hb. (g.%.)	W.B.C. ($x10^3$/cmm.)	P.C.V. (%)	Sp.G. (Blood)	Sp.G. (Plasma)
15/8/50	1	7.5	9.5	9.7	40	1.049	1.026
	2	7.2	7.8	8.0	36	1.046	1.024
	3	6.8	7.6	7.5	39	1.049	1.026
	4	7.6	8.7	8.2	41	1.052	1.027
	5	7.4	8.5	7.1	41	1.051	1.027
	6	8.3	8.4	7.2	38	1.050	1.027
29/8/	1	7.4	7.3	8.5	38	1.049	1.025
	2	6.7	6.6	5.9	31	1.049	1.025
	3	7.1	7.7	10.8	36	1.049	1.025
	4	7.4	7.6	7.0	40	1.049	1.025
	5	8.3	7.6	5.7	40	1.051	1.026
	6	7.4	7.6	6.1	40	1.051	1.027
12/9/	1	8.3	8.1	10.2	39	1.049	1.027
	2	5.7	6.8	7.6	31	1.049	1.027
	3	7.1	7.8	9.1	35	1.049	1.027
	4	7.1	7.8	7.6	40	1.049	1.027
	5	7.1	8.7	8.3	43	1.049	1.024
	6	8.1	9.5	8.4	41	1.050	1.026
18/9/	1	7.9	8.7	7.2	37	1.049	1.024
	2	6.6	7.1	8.1	31	1.049	1.026
	3	7.4	6.5	7.5	29	1.047	1.025
	4	7.3	7.9	7.2	40	1.051	1.027
	5	6.9	9.5	8.2	41	1.049	1.026
	6	6.6	8.6	7.8	41	1.051	1.025
27/9/	1	6.8	8.2	7.0	37	1.049	1.026
	2	6.7	8.1	6.8	33	1.049	1.026
	3	6.6	7.9	9.9	35	1.048	1.026
	4	6.3	9.1	6.8	39	1.049	1.026
	5	6.1	8.2	6.4	42	1.049	1.026
	6	6.1	8.5	6.8	39	1.049	1.027
4/10/	1	6.2	7.5	4.1	31	1.049	1.026
	2	5.9	7.4	4.0	29	1.049	1.026
	3	5.8	7.4	8.2	29	1.049	1.026
	4	6.3	9.0	6.2	34	1.049	1.027
	5	7.4	8.5	4.8	35	1.052	1.026
	6	6.3	7.7	4.5	31	1.049	1.027
9/10/	1	5.0	8.3	1.0	32	1.049	1.027
	2	5.0	7.7	0.9	25	1.049	1.026
	3	5.8	7.4	8.2	29	1.049	1.026
	4	5.6	8.6	6.1	36	1.050	1.026
	5 *	6.4	10.0	2.1	37	1.050	1.026
	6	5.9	9.6	1.3	31	1.051	1.027
11/10/	2	3.4	4.5	0.41	18	1.039	1.026
	6	4.6	5.7	0.32	25	1.043	1.027
15/10/	6	2.9	3.2	1.00	15	1.029	1.024
16/10/	2	4.3	5.7	1.20	21	1.039	1.026
19/10/	3	6.2	7.4	8.31	30	1.049	1.027
	4	6.4	8.5	5.81	33	1.049	1.025
31/10/	3	6.8	7.0	9.1	32	1.049	1.026
	4	6.5	9.3	10.5	37	1.051	1.026

* No. 5 subsequently following in more detail (see Appendix 4).

APPENDIX 4

(Lluest Farm, 1950.)

Heifer 5 on Active Bracken.

(For earlier hæmatological data, refer to Appendix 3)

Date.	R.B.C. (10^6/cmm.)	Ht. (g.%)	W.B.C. (10^3/cmm.)	W.B.C. Differentials. P. Seg.	P. Unseg.	L.	M.	E.	B.	Platelets (10^3/cmm.)	P.C.V. (%)	Fragility (% NaCl)	S.G. (Blood)	S.G. (Plasma)	Bleeding Time (mins.)	Clotting Time. (mins.)	Prothrombin Thre. (secs.)	Fluid Vol. of Clot. 24 hrs.	Fibrinogen (g.%)	Temp. (°F.)	Hæmorrhage. Faeces	Urine	Mucous Membranes
16.10.50	7.1	12.2	2.8	10.5	1.0	79	5	2	2.5[M]	1.86	36	0.52-0.8	1.056	1.029	7	4	15	13	-	102.8	-	-	-
18.10.	7.6	12.2	3.5	26.5	2.5	68.5	1.5	0.5	0.5[M]	2.6	34	0.48-0.76	1.054	1.029	-	7.5	15	24.5	-	-	-	-	-
20.10.	6.0	10.6	2.5	23	1.5	68.5	4.5	2.5	-	2.0	30	0.48-0.76	1.053	1.030	4.5	7.5	25	24	1.24	102.8	-	+++	-
23.10.	7.1	10.1	2.6	1	0.5	93	1	2.5	2[M]	1.1	29	0.48-0.76	1.053	1.031	6.5	7.5	18.5	47	1.56	103.6	-	++	-
25.10.	6.2	10.1	2.1	-	-	94.5	2	2.5	1[M]	1.86	27.5	0.44-0.72	1.051	1.032	6.5	18.0*	17	62.5	-	105.4	-	+++	-
26.10.	5.7	9.5	1.8	-	-	98	0.5	1.5	-	1.76	24	0.44-0.72	1.051	1.034	7	16[M]	20	62	1.84	107	-	+++	+
27.10.	5.9	9.5	0.9	-	-	100	-	-	-	1.3	23	0.44-0.68	1.052	1.034	4	10[M]	22	73	-	107	-	+++	+
28.10.	5.8	8.3	1.1	-	-	100	-	-	-	1.26	23.5	-	1.048	1.032	20	24[M]	25	51.5	1.91	107	-	+++	+
29.10.	2.4	5.0	0.5	-	-	100	-	-	-	0.5	15	0.44-0.68	1.037	1.026	-	-	-	-	0.99	-	++	+++	+

[M] Basket cells.

*Multiple small discrete clots formed, rendering assessment of clotting time difficult. These values are higher than what would be the correct time for commencement of Visual clot formation.

Addition of 0.2 ml. of thomboplastin preparation resulted in clotting times of 2 minutes.

APPENDIX 5

(Lluest Farm, 1950.)

Heifer 7a (on Active Bracken).

Date.	R.B.C. (10^6/cmm.)	Ht (g.%)	W.B.C. (10^3/cmm.)	W.B.C. Differentials. P. Seg.	P. Unseg.	L.	N.	E.	B.	Platelets (10^3/cmm.)	P.C.V. (%)	Fragility (%NaCl).	S.G. (Blood)	S.G. (Plasma)	Bleeding Time (mins.)	Clotting Time. (Mins.)	Prothrombin Time (Secs.)	Fluid Vol. of Clot. (%) 18 hrs.	Temp. (°F.)	Hæmorrhage. Faeces	Urine	Mucous Membranes.
15.8.50.	8.8	12.3	6.2	26	1	56	7	10	-	7.3	39	0.40-0.60	1.053	1.026	4	13	-	-	101.4	-	-	-
20.8.	10.6	16.0	10.0	34	2	55	6	3	-	3.1	50	-	1.061	1.029	-	6	-	-	-	-	-	-
6.9.	9.5	13.7	7.8	42	1	51	5	1	-	4.7	46	0.44-0.64	1.057	1.026	5	5	-	-	102.3	-	-	-
12.9.	8.8	13.6	6.0	22	2	69	5	2	-	3.0	39	0.44-0.64	1.056	1.026	4	5.5	-	3.0	102.3	-	-	-
20.9.	9.7	11.9	5.5	16	1	80	2	-	1	5.0	43	0.44-0.68	1.056	1.027	3.5	5.5	-	3.5	102.8	-	-	-
26.9.	9.4	11.9	4.0	14	5	73	8	0.5	-	3.3	37	-	1.056	1.027	2.5	4.5	22.5	13.0	100.8	-	-	-
3.10.	7.4	11.3	3.3	9	1.5	85	3	1	0.5[M]	3.3	36	0.44-0.68	1.054	1.028	-	3.5	22.5	12.0	101.5	-	-	-
9.10.	8.5	11.8	3.1	2.5	-	91	4.5	2	0.5[M]	3.4	39	0.48-0.68	1.054	1.027	15	6.5	22.0	47.0	102.5	-	-	+
10.10.	7.1	11.1	2.4	-	-	96	1	2	-	2.2	33	0.44-0.72	1.054	1.029	165	12.0	17.0	55.0	104.0	-	-	++
11.10 a.m.	7.2	9.7	1.7	1.5	-	98	0.5	0.5	-	1.4	29	0.40-0.68	1.050	1.028	30	4.5	21.0	61.0	106.8	-	-	++
11.10 p.m.	5.9	9.0	1.4	-	-	100	-	-	-	2.4	26	0.40-0.64	1.048	1.028	-	5	21.5	57.8	107.4	-	-	++
12.10 a.m.	5.7	8.4	0.8	-	-	100	-	-	-	1.0	23	0.40-0.64	1.044	1.027	9[M]	8	15.5	51.0	108.0	-	-	++
13.10 a.m.	5.2	7.7	0.6	-	-	100	-	-	-	1.0	24	0.40-0.64	1.042	1.029	**	-	18.0	23.0	106.4	-	-	++
13.10 p.m.	4.5	7.4	1.0	-	-	100	-	-	-	2.9	20	0.40-0.64	1.041	1.024	**	5	23.5	16.0	103	-	+	++

[M] Basket cells.

* Hæmatoma formed under skin.

** Failed to obtain bleeding points.

APPENDIX 6

(Lluest Farm, 1950.)

Heifer 7b (on Steamed Bracken).

Date.	R.B.C. (10^6/cmm.)	Hb (g.%)	W.B.C. (10^3/cmm.)	W.B.C. Differentials. P. Seg.	P. Unseg.	L.	M.	E.	B.	Platelets (10^5/cmm.)	P.C.V. (%)	Fragility (% Hæm.)	S.G. (Blood)	S.G. (Plasma)	Bleeding Time (mins.)	Clotting Time. (Mins.)	Prothrombin Time (Secs.)	Fluid Vol. of Clot. (%). 18 Hrs.	Temp. (°F.)	Hæmorrhage. Fæces	Urine	Mucous Membranes.
15.8.50.	8.1	12.16	13.0	26.0	2.0	59	5	8	-	6.4	38	0.40-0.60	1.056	1.028	3.5	5	-	-	101.4	None throughout the experimental period.		
29.8.	2.5	11.48	13.0	35.0	2.0	49	9	5	-	4.0	34	0.40-0.60	1.052	1.027	-	5	-	-	-			
4.9.	7.0	10.92	14.0	33.0	2.0	55	5	4	-	6.0	34	0.44-0.60	1.050	1.026	9½	3.5	-	-	-			
12.9.	7.7	11.34	12.0	22.0	2.0	56	11	9	-	4.7	32	0.40-0.64	1.051	1.026	2.5	5.5	-	4.8	102.2			
20.9	5.5	9.8	13.0	18.0	1.0	75	3	3	-	4.6	32	-	1.050	1.026	2.0	7	-	3.7	-			
26.9	7.0	9.66	10.0	10.0	-	69	12	4	-	4.1	31	0.44-0.68	1.050	1.026	3.5	6	-	4.5	100.8			
3.10.	6.0	10.78	10.9	29.0	1.0	67	4.5	4.5	-	4.3	33	0.44-0.68	1.052	1.028	-	6	25	1.5	100.4 (2nd)			
9.10.	6.0	9.94	11.2	17.0	0.5	72	9.5	1	-	5.7	32	0.44-0.68	1.048	1.026	4.0	4	22	0.7	-			
11.10.	5.9	9.38	11.0	24.5	0.5	64	10	1	-	3.4	29	0.44-0.68	1.048	1.028	-	4	20	11.8	103.0 (10th)			
19.10.	7.2	11.06	9.0	11.0	1.0	83	3	2	-	5.8	32	0.40-0.60	1.053	1.030	-	4	20	8.0	-			
24.10.	6.1	10.02	9.2	18.0	1.5	72.5	5	3	-	4.9	30	0.36-0.60	1.052	1.027	-	4.5	16	20.0	-			
31.10.	6.5	9.80	9.0	20.5	1.5	68	6	4	-	4.4	29	0.40-0.64	1.048	1.027	-	5	22	3.2	-			
11.11.	Put back on normal diet of hay, kale and cake.																					
12.12.	6.6	11.2	9.0	12.5	1.0	72	7	7.5	-	3.7	32	0.46-0.64	1.053	1.028	-	-	-	4.6	-			
9/2.51.	6.8	12.28	11.0	17.0	0.5	68.5	7.5	6.5	-	4.6	36	-	1.055	1.028	-	-	-	-	-			

APPENDIX 7

1951 Bovine Bracken Poisoning Experiment.

Roan (on Active Bracken).

Date.	6/3/	20/3/.	29/3/.	5/4/.	12/4/.	17/4/.	19/4/.	20/4/.	24/4/.	26/4/.	1/5/.	8/5/.	10/5/.	12/5/.
R.B.C. ($x10^6$/cmm.).	6.0	7.5	7.0	6.2	6.2	5.5	5.8	4.5	5.0	5.6	4.9	5.0	3.4	1.2
W.B.C. ($x10^3$/cmm.).	8.7	7.2	9.1	7.0	6.3	5.0	5.2	4.6	4.6	3.7	4.1	3.3	2.7	1.3
Polymorphs. (%)	28.5	14.0	12.0	19.0	24.0	20.5	10.0	6.5	2.0	3.5	15.5	3.0	0.5	-
Platelets. ($x10^5$/cmm.).	2.9	4.4	4.9	2.8	2.2	0.9	0.7	1.2	1.6	1.7	2.5	1.7	0.6	0.35
P.C.V. (%)	26.0	31.0	30.0	29.0	28.0	27.0	26.5	27.5	26.0	22.5	23.0	21.5	15.5	7.5
Clotting Time (mins.)	4.5	5.0	5.5	8.0	8.0	14.0	6.0	10.0	7.0	8.0	15.0	12.0	15.0	very prolonged.
Prothrombin Time (secs.)	19.0	18.0	-	-	-	20.0	21.0	-	21.0	21.0	26.0	22.0	22.0	26.0
Fluid Vol. of clot. (18 hrs.)	6.0	8.2	10.0	5.0	12.0	43.0	37.5	51.5	68.3	52.5	41.0	59.5	68.5	76.5
Rectal temp. (°F.)	-	-	102.2	-	-	103.4	101.0	102.0	105.6	104.4	101.4	101.0	101.2	105.6
Wt. (lbs.).	-	-	445.0	450.0	443.0	425.0	-	-	432.0	-	418.0	-	435.0	-

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APPENDIX 8

1951 Bovine Bracken Poisoning Experiments.
Black (on Active Bracken).

Date.	6/3/.	20/3/.	29/3/.	5/4/.	12/4/.	17/4/.	19/4/.	20/4/.	24/4/.	26/4/.	1/5/.	8/5/.	10/5/.	15/5/.	16/5/.	18/5/.	19/5/.
R.B.C. ($x10^6$/cmm.)	7.2	7.6	8.0	6.5	7.4	6.3	6.5	5.4	6.2	4.0	5.9	5.0	4.9	5.6	4.7	3.3	2.3
W.B.C. ($x10^3$/cmm.)	10.0	10.0	9.4	9.6	7.1	5.4	4.8	3.9	4.0	4.0	4.7	4.7	4.1	3.6	2.3	1.6	0.8
Polymorphs. (%).	18.0	17.5	28.5	24.0	18.0	17.5	10.0	4.5	-	4.0	15.0	18.0	11.0	0.5	-	-	-
Platelets. ($x10^3$/cmm.)	5.8	5.2	6.0	3.3	3.2	1.6	1.7	1.3	0.73	2.1	1.9	3.0	1.2	0.8	0.4	0.8	0.3
P.C.V. (%)	30.0	33.0	34.0	28.0	29.0	28.0	27.0	25.5	28.0	25.0	25.5	22.0	24.5	25.5	25.5	17.0	11.0
Clotting Time (mins.)	5.0	4.5	6.0	5.0	4.5	5.5	10.0	9.0	9.0	11.0	11.0	10.0	12.0	12.0	-	20.0	30.0
Prothrombin Time (secs.)	20.0	22.0	-	-	-	22.0	24.0	-	20.0	20.0	27.0	25.0	26.0	21.0	-	25.0	-
Fluid Vol. of clot. (18 hrs.).	6.0	5.0	12.0	6.0	12.3	30.0	29.0	54.9	60.0	62.0	15.8	67.5	99.5	54.5	25.5	56.2	69.0
Rectal temp. (°F.)	-	-	102.1	-	-	102.6	100.8	102.0	103.0	102.0	102.4	101.4	100.0	102.0	105.0	106.0	106.0
Wt. (lbs.)	-	-	530.0	520.0	514.0	493.0	-	-	500.0	-	482.0	-	-	-	-	-	-

APPENDIX 9

1951 Bovine Bracken Poisoning Experiments.
7b (on Active Bracken).

Date.	20/3.	29/3.	5/4/.	12/4/.	17/4/.	19/4/.	24/4/.	26/4/.	1/5/.	8/5/.	15/5/.	16/5/.	18/5/.	20/5/.	21/5/.
R.B.C. ($x10^6$/cmm.)	7.1	7.4	6.3	7.6	6.2	6.4	6.8	6.5	6.1	5.8	5.7	5.1	4.5	-	-
W.B.C. ($x10^3$/cmm.)	12.2	11.2	12.2	9.7	6.9	7.1	5.3	3.1	6.1	5.8	4.0	3.4	4.5	-	-
Polymorphs. (%).	19.5	16.0	23.0	22.5	16.0	17.0	3.5	1.5	6.5	8.5	2.5	4.5	0.5	-	-
P.C.V. (%)	36.0	38.5	35.0	36.5	33.0	33.0	31.5	32.0	30.5	30.0	30.5	28.0	26.0	-	-
Platelets ($x10^3$/cmm.)	3.9	3.9	3.0	1.9	1.7	0.9	1.4	1.2	2.5	3.6	2.2	0.5	1.6	-	-
Clotting time (mins.)	6.0	4.5	6.0	5.0	5.0	5.0	9.0	6.0	8.0	9.0	13.0	12.0	-	-	-
Prothrombin time (secs.)	29.0	-	-	-	23.0	23.0	20.0	20.0	25.0	22.0	21.0	26.0	-	-	-
Fluid Vol. of Clot. (18 hrs.)	4.0	10.5	1.0	1.5	15.0	17.0	34.5	15.8	35.5	42.0	99.5	52.2	-	-	-
Rectal temp. (°F.)	-	101.4	-	-	102.4	100.2	100.4	100.0	101.6	102.0	100.5	101.8	99.8	106.0	103.4
Wt. (lbs.)	-	652.0	624.0	639.0	631.0	-	625.0	-	614.0	-	-	-	-	-	-

APPENDIX 10

1951 Bovine Bracken Poisoning Experiments.
Red (on Active Bracken).

Date.	6/3/.	20/3/.	29/3/.	5/4/.	12/4/.	17/4/.	19/4/.	24/4/.	26/4/.	1/5/.	8/5/.	15/5/.	18/5/.	22/5/.	23/5/.	25/5/.	27/5/.
R.B.C. ($x10^6$/cmm.)	6.9	6.3	6.5	7.9	6.4	6.8	6.4	6.7	6.3	5.9	6.2	5.9	6.1	5.8	5.7	4.8	2.4
W.B.C. ($x10^3$/cmm.)	9.5	10.0	8.5	9.0	7.5	6.9	6.2	5.6	5.9	4.3	5.7	4.2	3.5	3.0	2.8	1.5	0.73
Polymorphs. (%.)	7.0	16.5	11.0	20.0	16.5	17.0	13.0	9.5	7.5	2.5	6.5	11.0	8.0	3.5	3.5	-	-
P.C.V. (%)	26.5	30.0	34.0	31.5	30.0	27.5	28.0	28.5	27.8	27.5	27.0	26.0	26.0	27.5	24.0	18.5	13.0
Platelets. ($x10^3$/cmm.)	4.6	5.1	4.1	2.7	3.0	2.1	1.4	1.3	2.5	2.0	2.3	1.0	1.6	0.53	-	2.0	0.03
Clotting Time (mins.)	4.0	5.0	5.0	5.0	5.5	9.0	5.5	6.5	7.0	8.0	9.5	11.5	11.0	10.0	10.5	30.0	-
Prothrombin Time (secs.)	18.0	18.0	-	-	-	22.0	23.0	21.0	20.0	22.0	25.0	21.0	22.0	-	28.0	42.2	30.0
Fluid Vol. of Clot. (18 hrs.)	9.5	4.0	11.0	0.5	18.0	18.4	58.1	56.1	58.5	20.5	20.0	38.0	38.4	58.5	61.0	43.5	65.0
Rectal temp. (°F.)	-	-	102.0	-	-	102.4	100.2	100.8	101.0	101.0	100.4	102.4	101.8	102.2	103.0	106.4	107.4
Wt. (lbs.)	-	-	495.0	487.0	467.0	467.0	-	465.0	-	435.0	-	-	-	-	-	-	-

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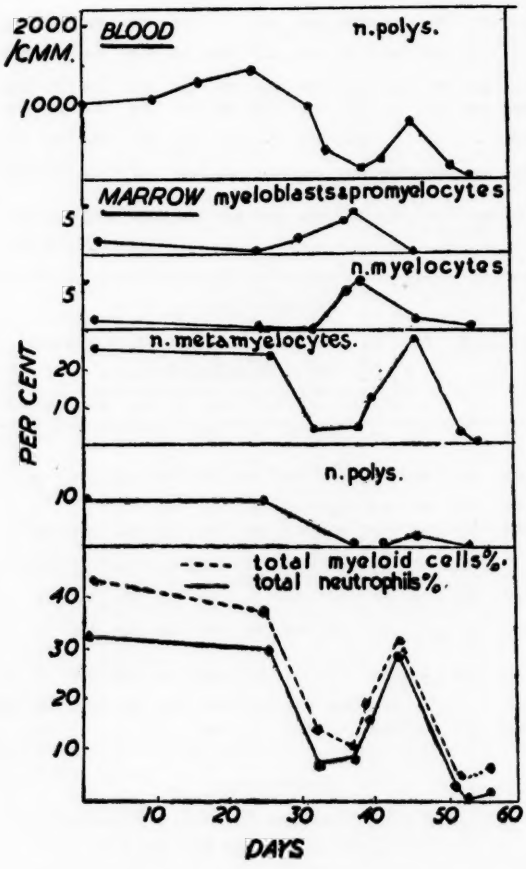

FIG. 8

1951 experiments. Showing correlation between the bone-marrow findings and the blood leucocyte count during production of bracken poisoning in the roan heifer.

Reference is made to these findings in Part II of this series, September issue, page 379.

REVIEW

LEHRBUCH DER ALLGEMEIN TIERZUCHT, by Walter Koch. Stuttgart: Ferdinand Enke. Price D.M. 29. (In German.)

THIS work on the general principles of animal breeding is intended to replace the book by Pusch which has for many years been a standard text for students of animal husbandry in the German-speaking countries but is no longer in print.

Like its predecessor, Koch's book is for a mixed circle of readers and is addressed to farmers and breeders as well as to agricultural students. Because of this, much of the discussion is elementary and topics receiving more elaborate and scientific treatment are frequently relegated to small print. It is always difficult to determine the success of this approach, but much of the present work could be understood by an intelligent reader with minimal biological knowledge.

The book covers a wider field than is usual in works of this kind, and in providing a general biological background to the many aspects of animal breeding touches upon a number of subjects, such as the origin of the domestic animals, that have an interest that is more academic than practical. Practical considerations, however, are not neglected and among the most comprehensive sections is the discussion of artificial insemination; this subject is treated from the point of view of the techniques involved and concerning its place in stock improvement policy.

Perhaps the least satisfactory part is that dealing with formal genetics; this is decidedly sketchy and can hardly be considered adequate—probably because the author is not optimistic concerning the contribution that genetics can make to livestock improvement under the conditions normally encountered.

Because it takes such a wide view and provides so much background information conveyed in a simple manner this book is more readable than most others on the subject: but for this very reason it is unlikely to be widely read in this country since those most likely to benefit from its contents rarely have the inclination to read a text in a language other than their own.

The printing and binding are of a high standard and the numerous illustrations are well chosen and relevant.

Memorial Fund Appeal

THE South Wales Division of the British Veterinary Association has announced the opening of a fund for the creation of a Research Scholarship to commemorate the late DR. JAMES THOMAS EDWARDS. The appeal is extended to all who wish to be associated in paying tribute to a great man, and it is pleasing to note that this commemoration will not be engraved in stone, but be devoted to the continuance of veterinary research, to which he gave his years and would humbly regard as "unfinished."

Contributions should be sent to D. B. Davies, Esq., M.R.C.V.S., Ministry of Agriculture, Lyric Buildings, Carmarthen.

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NOTICES

THE Department of Veterinary Service, Parke, Davis & Co., Ltd., Staines Road, Hounslow, announces the introduction of two new veterinary packs.

Chloromycetin Intramuscular 2 g., a microcrystalline preparation in rubber-capped vials for making into a suspension by the addition of water for injection. This product is particularly indicated for administration to large-animal patients and to small-animal patients who will not for various reasons accept oral medication.

Benadryl Parenteral 50 c.c. presents this potent antihistaminic agent in a convenient form for administration to animal patients. The rubber-capped vial has been specially produced to meet the needs of the large-animal practitioner as a multi-dose preparation for administration to cattle and horses where doses of 25 c.c. may be required.

THE Ministry of Agriculture have published a report of the severe outbreak of swine fever in July, 1954, on the Earl of Shrewsbury's Estate at Ingestre and the apparent lack of immunity provided by the vaccine used. In this report it is stated that since February, 1954, the vaccine in use was of foreign origin. We have been requested by the International Serum Co., Ltd., London, to publish a statement that Crystal Violet Vaccine, "Behring," which is imported and distributed by them, and is widely used in this country, was not the foreign vaccine used at Ingestre.

THE Animal Health Trust announce a change of address. As from Saturday, September 25, 1954, their head office has been moved from Abbey House to 14 Ashley Place, Westminster, London, S.W.1 (facing Westminster Cathedral). New Telephone: VICtoria 3207/8.

DEOSAN, LTD., announce a change of address of their head office, effective from October 9, 1954. The new premises are at 42-46 Weymouth Street, London, W.1. Telephone: HUNter 0731.

Publishers' Notices

THE BRITISH VETERINARY JOURNAL, with which is incorporated THE VETERINARY JOURNAL, is published monthly, and copy for advertisements should be in the hands of the advertisement manager not later than the 20th of the preceding month, if proof is required. Tel.: Temple Bar 3386.

Letters for the Journal, literary contributions, reports, notices, books for review, exchanges, new instruments or materials, and all matter for publication (except advertisements) should be addressed to the Editor.

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